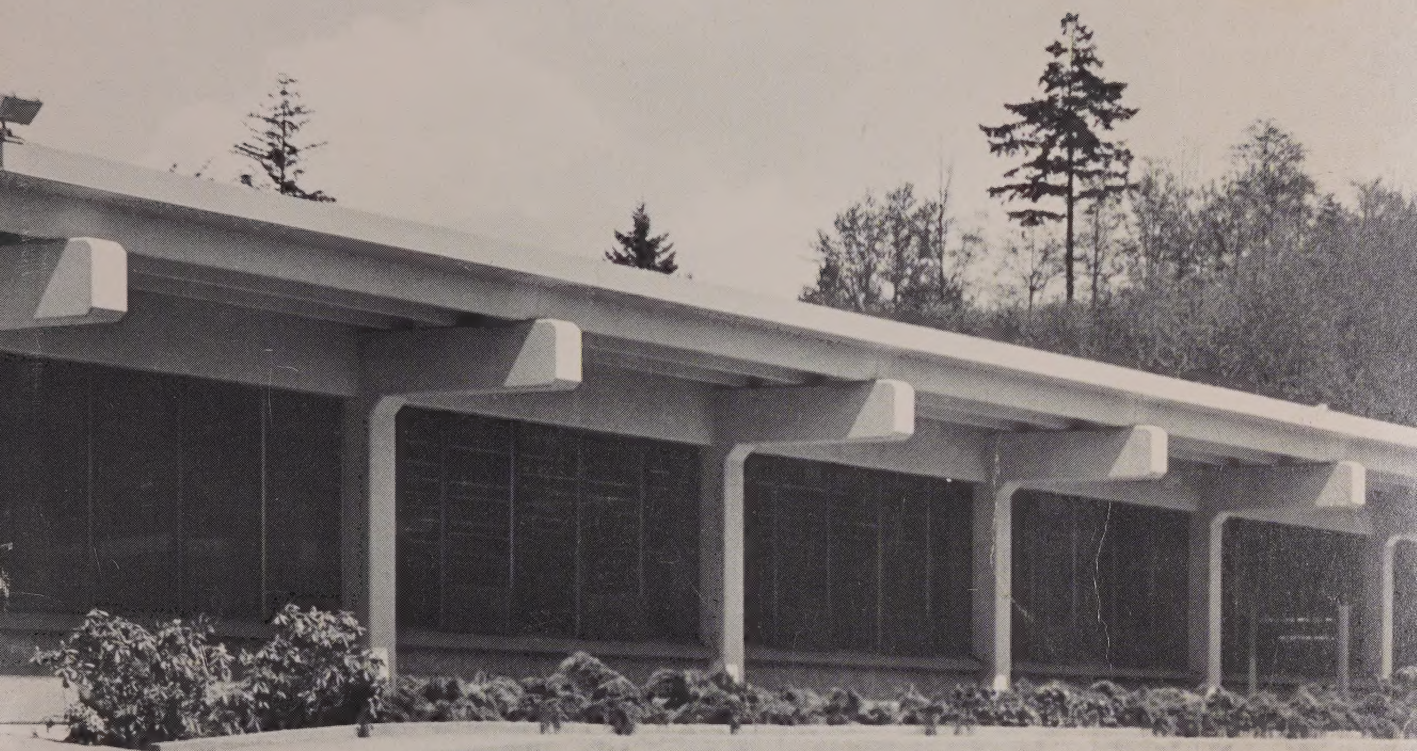
Instruction Manual

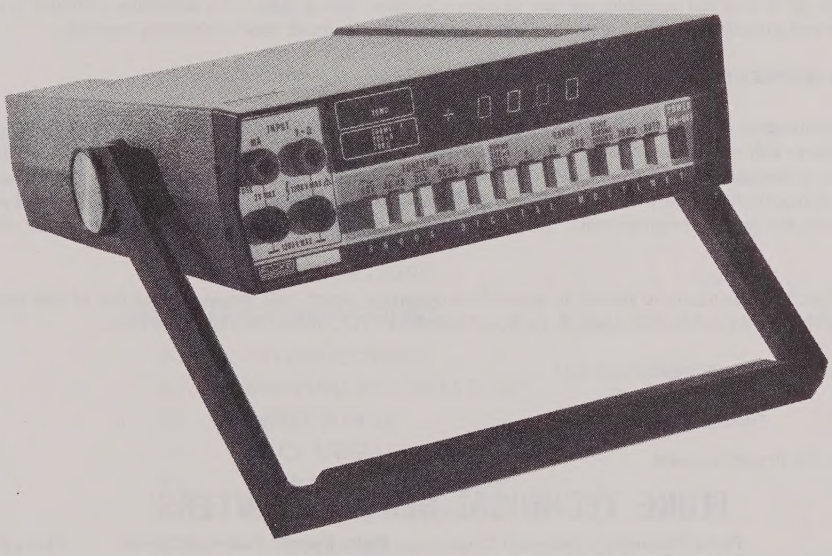
M22



FLUKE®

JOHN FLUKE mfg. co., inc.
SEATTLE, WASHINGTON

JOHN FLUKE MFG. CO., INC.
P. O. Box 7428
Seattle, Washington 98133



MODEL

8600A

DIGITAL MULTIMETER

NOVEMBER - 1974

WARRANTY

The JOHN FLUKE MFG. CO., INC.* warrants each instrument manufactured by them to be free from defects in material and workmanship. Their obligation under this Warranty is limited to servicing or adjusting an instrument returned to the factory for that purpose, and to making good at the factory any part or parts thereof; except tubes, fuses, choppers and batteries, which shall, within one year after making delivery to the original purchaser, be returned by the original purchaser with transportation charges prepaid, and which upon their examination shall disclose to their satisfaction to have been thus defective. If the fault has been caused by misuse or abnormal conditions of operations, repairs will be billed at a nominal cost. In this case, an estimate will be submitted before work is started, if requested.

If any fault develops, the following steps should be taken:

1. Notify the John Fluke Mfg. Co., Inc.,* giving full details of the difficulty, and include the Model number, type number, and serial number. On receipt of this information, service data or shipping instructions will be forwarded to you.

2. On receipt of the shipping instructions, forward the instrument prepaid, and repairs will be made at the factory. If requested, an estimate will be made before the work begins, provided the instrument is not covered by the Warranty.

"The foregoing warranty is in lieu of all other warranties, express or implied, including but not limited to, any implied warranty of merchantability, fitness or adequacy for any particular purpose or use. Fluke shall not be liable for any special, incident or consequential damages."

SHIPPING

All shipments of John Fluke Mfg. Co., Inc.* instruments should be made via Railway Express**prepaid. The instrument should be shipped in the original packing carton, or if it is not available, use any suitable container that is rigid. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be thoroughly inspected immediately upon receipt. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to John Fluke Mfg. Co., Inc.* Upon receipt of this report, you will be advised of the disposition of the equipment for repair or replacement. Include the model number, type number, and serial number when referring to this instrument for any reason.

The John Fluke Mfg. Co., Inc.* will be happy to answer all application questions which will enhance your use of this instrument. Please address your requests to: JOHN FLUKE MFG. CO., INC., P. O. Box 7428, SEATTLE, WASHINGTON 98133*.

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TWX: 910-989-1656

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8207 Millet
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Tel: 713-923-2796
TWX: NONE

Tucker Electronics
Clay Aclin, Service Mgr.
1717 Jupiter
Garland, TX 75040
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Rev. 10/74

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Section 1

Introduction & Specifications

1-1. INTRODUCTION

1-2. The Model 8600A is a compact and light-weight digital multimeter (DMM). It features a 4½ digit display, push-button selection of range and function, auto polarity, self locating decimal point, self zeroing to eliminate offset uncertainties, and overload protection for all ranges. Auto-ranging can be selected when the ac volts, dc volts or kil-ohms functions are selected. Several options and accessor-ies for the 8600A are available (see Section 6).

1-3. Push-button controls allow the selection of five ac and dc voltage ranges, five ac and dc current ranges, and six resistance ranges. The measurement capabilities of the 8600A range from 10 microvolts to 11999 volts ac and dc, 10 nanoamperes to 1.9999 amperes ac and dc, and 10 milliohms to 19.999 megohms.

1-4. The front-panel readout features a 4½ digit display using light emitting diodes (LED's). The display includes a self locating decimal point and a + or – polarity indicator. Full-scale readout is 19999 for all ranges and functions except the 1200 volt ac and dc range, which is 11999. A blinking 18888 readout indicates that the 8600A is being operated in an overload condition and provides a test for all seg-ments in the display.

1-5. Front panel input connectors are banana type and provide separate connections for current, and volt-ohm inputs. Both the current and volt-ohm inputs are referenced to a common input which is isolated from earth ground and can operate at a potential of up to ±1000V dc or peak V ac with reference to earth ground.

1-6. The overload features of the 8600A include a fused current input and an overvoltage protected volt-ohm input. This protection applies for any function and range selected.

1-7. Several options and accessories are available for use with the 8600A. The options are listed and described in Table 1-1, and must be specified at time of purchase. The accessories are listed and described in Table 1-2. Accessories are compatible with all options and can be ordered at time of purchase or after purchase. Detailed information concerning each option and accessory is given in Section 6 of this manual.

Table 1-1. 8600A OPTIONS

MODEL NO	DESCRIPTION
8600A-01	Basic unit w/battery option
8600A-02	Basic unit w/data output unit

Table 1-2. 8600A ACCESSORIES

MODEL NO.	DESCRIPTION
C80	Vinyl Carrying Case w/strap
C86	Molded Hard-Shell Carrying Case
A80	Deluxe Test Lead Kit
801–600	Clamp-on AC Current Probe (2A to 600A)
80K–40	High Voltage Probe; 1kV to 40kV
81RF	RF Probe: 100kHz to 100 MHz
81RF–1	RF Probe 100 kHz to 500 MHz
M00-100-714	Front Panel Cover
M00-200-611	Rack Mount, Center
M00-200-612	Rack Mount, Offset Left or Right
M00-200-613	Rack Mount, Side-by-Side

1-8. Input power for the 8600A is switch selectable to provide operation at either 115V ac or 230V ac line power The 8600A will also operate from a 100V ac line source when in the 115V switch position. The 8600A-01 (battery

power option) is configured at the factory for 100V ac 50 Hz, 115V ac 60 Hz, or 230V/240V ac 60 Hz line power operation. The instrument must not be operated from any other line power than that for which it is configured (see the decal on the bottom of the case). The operation of front panel controls is the same for all power configurations of the 8600A, 8600A–01, and 8600A–02 instruments.

1-9. SPECIFICATIONS

1-10. Specifications for the Model 8600A are presented in Table 1-3, under headings of DC VOLTAGE, AC VOLTAGE, DC CURRENT, AC CURRENT, OHMS, and GENERAL. Specifications for each option are listed under the option heading.

Table 1-3. MODEL 8600A SPECIFICATIONS

DC VOLTAGE	
Ranges	±200 mV, ±2V, ±20V, ±200V, ±1200V
Accuracy:	90 Days (15°C to 35°C)
200 mV range	±(0.04% of input +0.01% of range)
2V, 20V, and 200V ranges	±(0.02% of input +0.005% of range)
1200V range	±(0.02% of input +0.008% of range)
Temperature Coefficient:	
200 mV range	±(0.003% of input +0.001% of range)/°C
2V to 1200V ranges	±(0.001% of input +0.0005% of range)/°C
Input Impedance:	
200 mV and 2V ranges	> 1000 megohms
20V, 200V and 1200V ranges	10 megohms
Normal Mode Rejection	60 dB minimum @ 50 Hz, 60 Hz
Common Mode Rejection	120 dB minimum @ dc and 50 Hz, 60 Hz (with 1kΩ in either lead)
Zero Stability	Auto zeroed on all ranges
Ranging	Full autoranging, or manual ranging
Polarity	Automatic bipolar, + or — display
Overload	±1200V dc or 1700V peak ac applied continuously to any range.
Response Time to Rated Accuracy Within Range	1 second maximum to displayed input
AC VOLTAGE	
Ranges	200 mV, 2V, 20V, 200V, 1200V
Accuracy:	90 Days (15°C to 35°C)
200 mV range (100% to 1% of range)	30 Hz - 50 Hz; ±(0.5% of input +0.10% of range) 50 Hz - 10 kHz; ±(0.2% of input +0.08% of range) 10 kHz - 50 kHz; ±(0.5% of input + 0.10% of range) 50 kHz - 100 kHz; ±(0.5% of input + 0.5% of range)
2V, 20V and 200V ranges (100% to 1% of range)	50 Hz - 10 kHz; ±(0.2% of input + 0.015% of range) 30 Hz - 50 Hz and 10 kHz - 50 kHz; ±(0.5% of input + 0.025% of range) 50 kHz - 100 kHz; ±(1.0% of input + 0.05% of range)

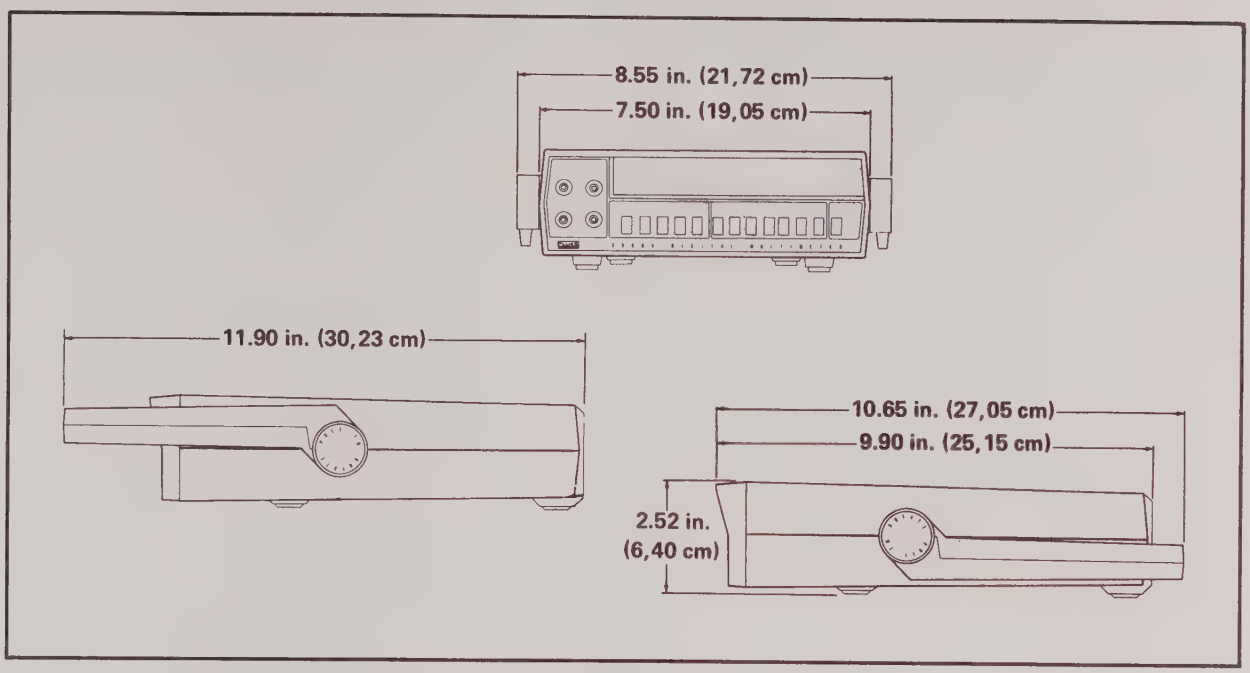

Figure 1-1. MODEL 8600A OUTLINE DRAWING

Table 1-3. MODEL 8600A SPECIFICATIONS

1200V range (100% to 1% of range)	10V to 500V, 50 Hz - 10 kHz; ±(0.2% of input +0.03% of range) 500V - 1200V, 50 Hz - 10 kHz; ±(0.37% or input + 0.03% or range) 10V to 1200V, 30 Hz to 50 Hz, 10 kHz to 20 kHz, ±(0.5% of input +0.08% of range)
Temperature Coefficient:	
200 mV range	±(0.015% of input + 0.005% of range)/°C
2V to 1200V ranges	±(0.01% of input + 0.002% of range)/°C
Input Impedance	2 megohms shunted by less than 100 pf
Response Time to Rated Accuracy Within Range	1.5 seconds maximum to displayed input
Overload	1200V rms, 1700V peak ac applied continuously to any range - not to exceed 2 x 10^7 V Hz product (20 kHz max at 1000V)
Ranging	Full autoranging, or manual ranging
DC CURRENT	
Ranges	200 μA, 2 mA, 20 mA, 200 mA, 2000 mA
Ranging	Manual ranging
Accuracy: 90 Days (15°C to 35°C)	
All Ranges	±(0.1% of input + 0.01% of range) on all ranges
Temperature Coefficient:	
All Ranges	±(0.003% of input + 0.001% of range)/°C
Voltage Burden	0.3V maximum up to 200mA: 0.6V maximum up to 2A
Overload	Protected to 2A on all ranges: fused above 2A
Response Time to Rated Accuracy Within Range	1 second maximum to displayed input
AC CURRENT	
Ranges	200μA, 2 mA, 20 mA, 200 mA, 2000 mA
Ranging	Manual ranging
Accuracy: 90 Days (15°C to 35°C)	
	50 Hz - 10 kHz; ±(0.3% of input + 0.08% of range) all ranges (except 2000 mA range 50 Hz - 5 kHz) 30 Hz - 50 Hz; ±(0.6% of input + 0.1% of range) all ranges
Temperature Coefficient:	
All Ranges	±(0.015% of input + 0.005% of range)/°C
Voltage Burden	0.3V maximum up to 200mA: 0.6V maximum at 2A
Overload	Protected to 2A on all ranges, fused above 2A
Response Time	1 sec. max. to rated accuracy
OHMS	
Ranges	200Ω, 2kΩ, 20 kΩ, 200 kΩ, 2000 kΩ, 20 MΩ
Ranging	Full autoranging, or manual ranging

Table 1-3. MODEL 8600A SPECIFICATIONS

Accuracy:	**90 Days (15°C to 35°C)**
200Ω range	±(0.1% of input + 0.015% of range)
2kΩ	±(0.1% of input + 0.005% of range)
20 kΩ to 2000 kΩ ranges	±(0.05% of input + 0.005% of range)
20 MΩ	±(0.2% of input + 0.005% of range)
Temperature Coefficient:	
2kΩ to 2000 kΩ ranges	±(0.003% of input +0.0005% of range)/°C
200 Ω and 20 MΩ range	±(0.005% of input + 0.001% of range)/°C
Configuration	Two wire
Overvoltage Protection	250V rms or dc, applied continuously
Maximum Open Circuit Voltage	5 volts
Response Time:	
200 Ω to 2000 kΩ ranges	1 second maximum to displayed input
20 MΩ range	4 seconds maximum to displayed input

Current Through Unknown

200Ω	2kΩ	20 kΩ	200 kΩ	2000 kΩ	20 MΩ
1mA	1mA	100μA	10μA	1μA	0.1μA

GENERAL

Display	Seven-segment LED .3" character height, automatic decimal location
Size	8.55" wide x 2.52" high x 10.65" deep (See Figure 1-1) 21.72 cm x 6,40 cm x 27,05 cm
Weight	3.5 lbs. (1.6 kg) line power, 4.5 lbs. (2.1 kg) with batteries
Operating Temperatures	0°C to +50°C
Storage Temperature	–40°C to +75°C (–40°C to + 60°C with batteries)
Humidity Range	80% RH, +5°C to +35°C 70% RH, +35°C to +50°C
Overload Indication	Flashing display of +18888 (built in segment test of LED display) for out of range indication
Maximum Common Mode Voltage	±1000V, dc or peak ac
Power	100/115/230V ac ±10% 50 or 60 Hz, 7 watts line powered 10 watts battery powered

BATTERY PACK, OPTION –01

Continuous Operation	8 hours typical (6 hours minimum)
Charge Time	16 hours maximum

DATA OUTPUT UNIT (DOU), OPTION –02

Available Data	Digits, polarity (both logic senses), range, and reference output
Data Coding	8-4-2-1 BCD positive true parallel
Logic Levels	1 = +5V, 0 = 0V
Drive Capability	All output can drive a minimum of two TTL loads. (i.e. sink 3.2 mA)
Flags	Busy, $\overline{\text{busy}}$, and overload
Controls	External trigger (positive going edge trigger), and External trigger enable

Section 2
Operating Instructions

2-1. INTRODUCTION

2-2. This section of the manual contains information regarding installation and operation of the Model 8600A DMM. It is recommended that the contents of this section be read and understood before any attempt is made to operate the instrument. Should any difficulties arise during operation, please contact your nearest John Fluke Sales Representative or the John Fluke Mfg. Co., Inc., P.O. Box 7428, Seattle, WA 98133; telephone (206) 774-2211. A list of Sales Representatives is located in Appendix C of this manual.

2-3. SHIPPING INFORMATION

2-4. The 8600A is packaged and shipped in a foam-packed container. Upon receipt of the instrument, a thorough inspection should be made to reveal any possible shipping damage. Special instructions for inspection and claims are included in the shipping carton.

2-5. If reshipment of the instrument is necessary, the original container should be used. If the original container is not available, a new container can be obtained from the John Fluke Mfg. Co., Inc. Please reference the instrument model number when requesting a new shipping container.

2-6. INPUT POWER

2-7. The 8600A can be operated from 100, 115, or 230V ac 50 or 60 Hz power lines, as selected by line power select switch S14. Before connecting the instrument to line power, check and, if necessary, set the instrument for operation at local line voltage as follows:

CAUTION!

Refer to Section 6 Option –01 for requirements of line voltage change for 8600A –01 instruments.

a. Remove the phillips screw from the rear of the instrument.

b. Remove the case; pull it straight back from the front panel.

c. Locate the power selection switch; near the rear or the main pcb assembly.

d. For 100 or 115V ac operation position the slide switch so that 115 appears in the slide aperture. For 230V/240V ac operation set the switch so 230 appears.

e. Replace the case and phillips screw.

2-8. The rear panel power input connector is a three-prong, U-ground connector which permits the instrument to be connected, via the power cord, to the appropriate line power. The offset prong on this connector is connected to the 8600A power supply, and should be connected, via the power cord, to a high quality earth ground.

2-9. RACK INSTALLATION

2-10. The 8600A is designed for either bench-top use or for installation in a standard 19-inch equipment rack using an optional accessory rack mounting kit. Rack mounting kits are available for left, right, center, or side-by-side mounting of the 8600A. Information regarding installation of the rack-mounting accessories is given in Section 6 under Rack Installation.

2-11. OPERATING FEATURES

2-12. The location of all 8600A controls, indicators and connectors are shown in Figure 2-1, and described in Table 2-1.

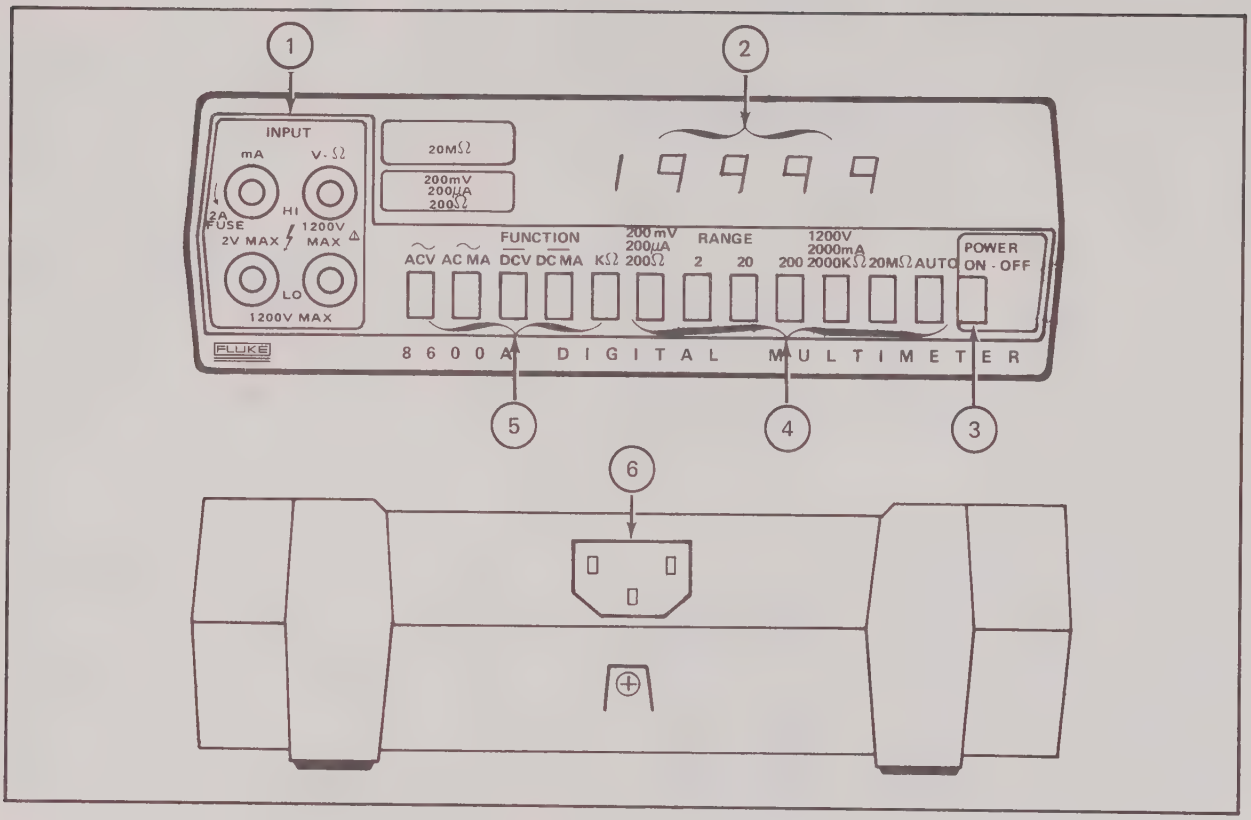

Figure 2-1. 8600A CONTROLS, INDICATORS AND CONNECTORS

Table 2-1. 8600A CONTROLS, INDICATORS AND CONNECTORS

FIG. 2-1 REF. NO.	NAME	FUNCTION
1	INPUT Connectors	Provides the input connections necessary to make current (MA), voltage (V), or resistance (Ω) measurements. All measurements are referenced to the LO INPUT terminals.
2	Digital Readout	Provides a 4½ digit display (19999 maximum) or the measured input. The readout also includes a properly positioned decimal point, and a + or − sign for dc voltage and current measurements.
3	POWER Switch	Switches the instrument on or off. The instrument is turned on when the switch is depressed.
4	RANGE Switches	Provide pushbutton selection of ranges which correspond to the selected function (current, voltage, or resistance). The available ranges are: Voltage: 200 MV, 2, 20, 200, 1200V and AUTO Current: 200μA, 2, 20, 200, 2000 MA Resistance: 200Ω, 2, 20, 200, 2000kΩ, 20MΩ, and AUTO
5	FUNCTION Switches	Provide pushbutton selection of one-of-five measurement functions; ACV, AC MA, DCV, DC MA, or KΩ.
6	Input Power Connector	Provides the means of connecting the instrument through the power cord to the ac power line.

2-13. OPERATING NOTES

2-14. The following paragraphs describe various conditions which should be considered before operating the 8600A.

2-15. Option Information

2-16. Supplementary information is necessary when operating an 8600A which is equipped with one of the available options. Detailed information regarding the operation of each available option is given in Section 6, Options and Accessories.

2-17. Fuses

2-18. The 8600A is equipped with a line power fuse, and a current overload fuse for the current measuring function. The line fuse is located near the transformer on the inside of the instrument. To gain access, remove the retaining screw on the rear of the case and remove the instrument from the case. When replacement is necessary, use an AGC 1/8A fuse. The current input fuse is located behind the front-panel MA INPUT terminal, and is accessed by turning (ccw) and removing the MA INPUT terminal. Use a John Fluke 346940 replacement fuse or equivalent 2A fast-blo fuse 1 inch in length.

2-19. Overrange Indication

2-20. The front panel display, in addition to providing a measurement reading, is designed to serve as an overrange indicator. When the full scale capability of the selected range for any function is exceeded, the display will blink while indicating a 18888 reading. The presence of an overrange indication does not necessarily mean that the instrument is being exposed to a damaging input condition.

2-21. Input Overload Protection

CAUTION

Exceeding the maximum input overload conditions can damage the 8600A.

2-22. Each range and function of the 8600A is equipped with input overload protection. The maximum allowable input overload conditions for each function and range are given in Table 2-2.

2-23. Autoranging

2-24. Autoranging can be selected when the 8600A is in the VDC, VAC, or KΩ functions. When the AUTO pushbutton is depressed the 8600A will select the lowest range that will display the value of the input signal without causing an overrange indication. Autoranging stops when one of the individual range pushbuttons is depressed.

Table 2-2. BASIC MEASUREMENT INSTRUCTIONS

DESIRED MEASUREMENT	8600A				REMARKS
	SELECT FUNCTION	SELECT RANGE	INPUT CONNECTION	MAXIMUM INPUT	
DC Volts	DCV	200 MV, 2, 20 200, or 1200V	V-Ω and COMMON	1200V dc or 1700V peak ac, any range	Auto-polarity Auto-ranging
DC Milliamperes	DC MA	200 μA, 2, 20 200 or 2000MA	MA and COMMON	2A (Fuse Protected)	Manual-ranging Auto-polarity
AC Volts	ACV	200 MV, 2, 20 200 or 1200V	V-Ω and COMMON	1200V rms (sinusoidal), 1700V peak ac, any range	Auto-ranging Average Responding calibrated to read rms ac volts.
AC Milliamperes	AC MA	200 μA, 2, 20 200, or 2000 MA	MA and COMMON	2A (Fuse Protected)	Manual-ranging Average Responding
Kilohms	KΩ	200Ω, 2, 20, 200, 2000 kΩ, or 20 MΩ	V-Ω and COMMON	250V dc or 250V ac peak, any range	Auto-ranging

2-25. OPERATION

2-26. Use the following procedure for initial turn-on of the 8600A;

a. Connect the instrument to ac line power. (See Paragraph 2-6)

b. Depress the POWER switch.

c. In accordance with Table 2-2, select the desired function and range; connect the test leads to the corresponding input connectors.

NOTE

Supplemental instructions may be required for instruments with options installed. These instructions, if any, are given in Section 6, Options and Accessories.

Section 3
Theory of Operation

3-1. INTRODUCTION

3-2. The theory of operation for the Model 8600A is arranged under two major headings. The first, titled OVERALL FUNCTIONAL DESCRIPTION, discusses the overall operation of the instrument in terms of the functional relationships of the major circuits. The second section is titled CIRCUIT DESCRIPTION and deals with the internal operation of each major circuit in more detail. Block diagrams and simplified circuit diagrams are included in these sections. The complete schematic diagrams are located at the end or the manual.

3-3. OVERALL FUNCTIONAL DESCRIPTION

3-4. Introduction

3-5. The 8600A circuitry can be divided into three major sections. The first of the three sections, termed Input Signal Conditioners, (see Figure 3-1) comprises the Input Divider, Ohms Converter, AC Converter and Current Shunt. The second section is the A/D (analog-to-digital) Converter and the third is the Control and Display section. The basic operational relationship of these functional areas will be discussed in the following paragraphs.

3-6. Input Signal Conditioners

3-7. The term, input signal conditioner, describes the basic function of the four subsections grouped under it. The input divider, current shunts ohms converter, and ac converter provide the A/D converter with a dc analog voltage representative of the input (ac volts, dc volts, ac current, dc current, or resistance) applied to the instrument. The path that each input signal follows as it is conditioned for the A/D converter is illustrated in Figure 3-1.

3-8. DC voltages applied to the input terminals are directed via function switch contacts directly to the A/D converter in the 200 mV and 2V ranges but to the input divider in higher ranges. The input divider divides it by 10, 100 or 1000 in the 20, 200 and 1200 volt ranges respectively. The A/D converter is provided with a dc voltage level, representing full scale, of 200 mV for the 200 mV range and two volts for the 2V through 1200V ranges.

3-9. An ac voltage input to the instrument is applied through switch contacts to the ac converter. The converter then changes the ac input to an equivalent dc voltage for the 200 mV and 2V ranges. In the 20 V through 1200 V ranges the feedback within the ac converter is changed by reed (relays) so that the dc voltage output to the A/D converter is two volts for a full scale indication on the 20 V and 200 V ranges and 1.2 volts on the 1200 V range.

3-10. When making a resistance measurement the unknown resistance, connected across the input, is supplied with a known value of current by the ohms converter and input divider. The voltage drop across the unknown resistance is then applied to the A/D converter as a direct representation of that resistance. The input divider is used to change the amount of current applied to the unknown resistance when different ranges are selected.

3-11. When making current measurements (ac or dc) the unknown current is applied directly, via the MA INPUT terminals, to the current shunt. The unknown current is directed, via the range switch contacts, through a precision resistor network so that the voltage developed

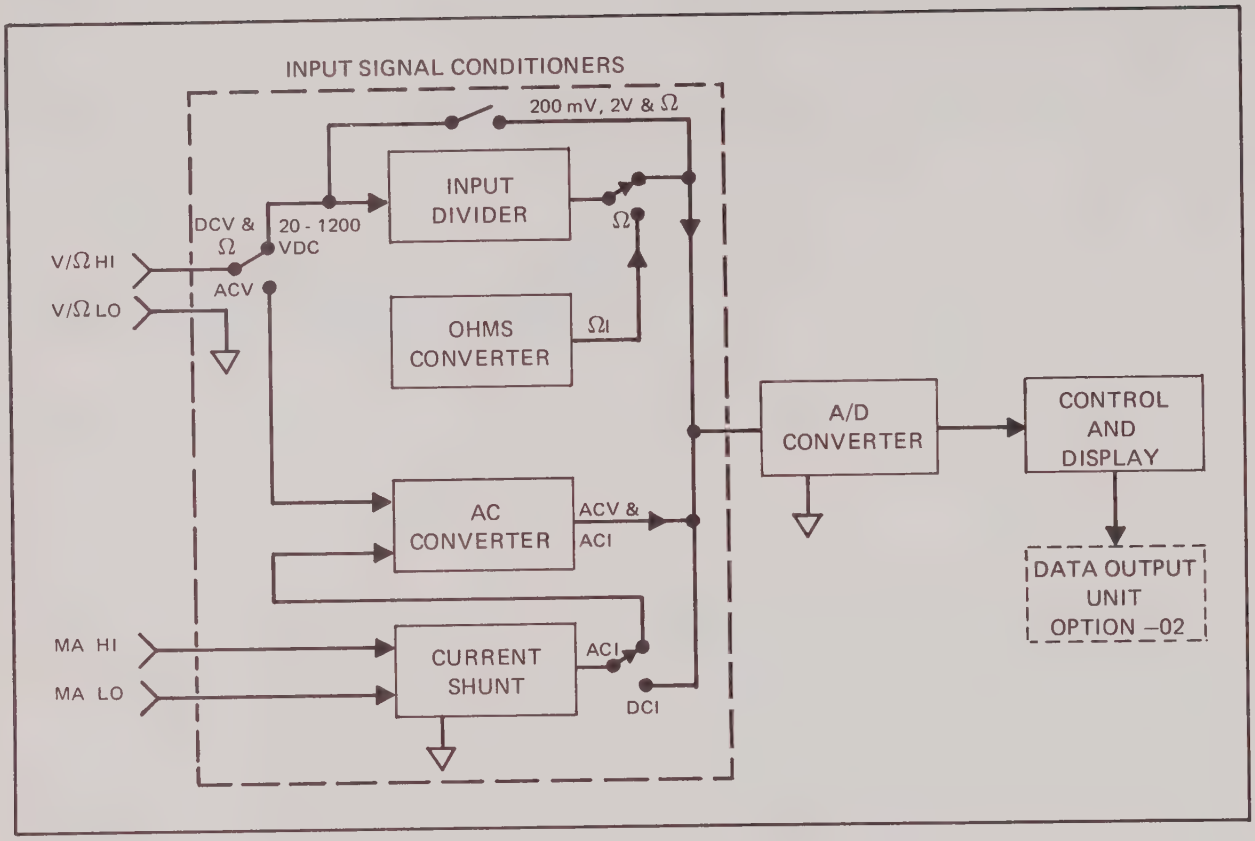

Figure 3-1. OVERALL FUNCTIONAL BLOCK DIAGRAM

across the known resistance is representative of the unknown current. In the case of dc current inputs the representative dc voltage is applied directly to the A/D converter, while in the case of ac current inputs the representative ac voltage is directed to the ac converter first and then to the A/D converter as an equivalent dc voltage.

3-12. A/D Converter

3-13. The A/D Converter receives the dc voltage output from one of the Input Signal Conditioners and integrates it for 100 mS. Figure 3-2 is an illustration of the output of the integrator. The slope of the integrator output voltage during the Integrate Period is directly proportional but opposite in polarity to the A/D Converter input. At the end of the integrate period the signal conditioner output is disconnected from the A/D input and a dc reference voltage is connected to the input. The A/D converter then integrates the reference voltage, of opposite polarity, which results in a constant slope returning the integrator output toward zero (Read Period). Since the read period slope is held constant the time required for the A/D integrator output voltage to return to zero is proportional to the instrument input.

3-14. The digital representation of the input is obtained by counting the number of cycles of a clock frequency that occur from the start of the read period to the point where the A/D integrator output voltage returns to the zero detect level. The A/D Converter supplies the Control and Display section with a compare signal at the end of the read period. The compare signal stops the counting of the clock oscillator pulses so that the analog value of the instrument input is now digitally represented by the number of oscillator pulses counted in the 4½ digit counter.

3-15. Control and Display

3-16. The Control and Display section provides the properly timed signals that direct the correct Input Signal Conditioner output to the A/D Converter during the integrate period. At the end of integrate time period the Control and Display section connects the appropriate reference supply to the A/D Converter input for the read period. The output of a 1 MHz oscillator is used to maintain the proper timing of the control signals as well as provide the base frequency from which the 100 kHz clock signal for the read period is produced.

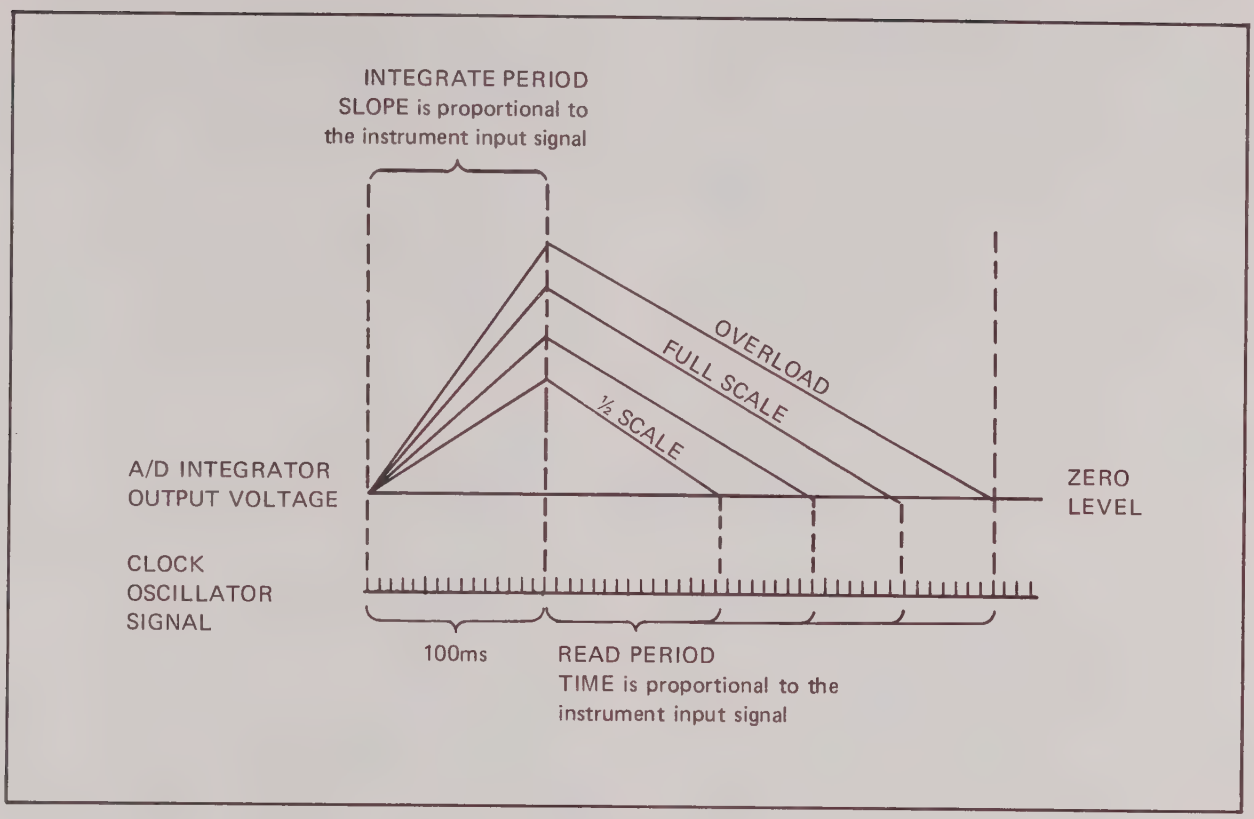

Figure 3-2. TIMING DIAGRAM FOR DUAL-SLOPE A/D CONVERSION

3-17. The clock oscillator pulse count, accumulated during the read period, is applied to the LED display to produce the digital readout of the instrument input signal. The range information from the selected range switch positions the decimal point and illuminates the proper display annunciator.

3-18. Data Output Unit (DOU)

3-19. The DOU provides the display data as a rear panel card-edge output. The bcd information presented to the instrument display (polarity, overload, range code, and digit) is also applied to the DOU input. A busy flag is provided so that the output data may not be used while the 8600A is feeding a new input measurement to the DOU. A register pulse train plus one of the data strobe signals time the data transfer to insure that all the data supplied to the DOU output is stable and not taken during transition periods.

3-20. CIRCUIT DESCRIPTION

3-21. The following circuit descriptions are keyed to the functional blocks defined in the overall functional block diagram of Figure 3-1. Corresponding functional blocks are defined in more detail using either simplified block diagrams or by referring to the schematics. Schematics for the 8600A circuits are provided in Section 7.

3-22. Input Signal Conditioners

3-23. INPUT DIVIDER

3-24. The Input Divider comprises a series connected resistor network (R3, R4, R5, R6, R7, and R8) totaling approximately ten megohms. This network is tapped at three points to provided division ratios of 10:1, 100:1, and 1000:1. Relays K2, K3, and K4 each select one of the division ratios; as directed by the range switches.

3-25. OHMS CONVERTER

3-26. The Ohms Converter produces a known amount of current that when applied to an unknown resistance (Rx), connected across the input terminals, will develop a voltage proportional to the value of Rx. Figure 3-3 is a simplified circuit diagram of the Ohms Converter and other circuits needed to make a resistance measurement.

3-27. The operating conditions of the Ohms Converter, as shown in Table 3-1, are changed by the range relays to create the current (Ix) needed to develop a dc voltage for

the A-D Converter. The conditions created by selecting the 2000KΩ, 8600A RANGE will be used in the following operational description.

3-28. When the 2000KΩ range is selected all the range relays (K2 thru K5) are open. This places all the Input Divider resistors (Ro = 9990 KΩ) in series with the Ohms Converter 10K ohm output resistor (R27 and R28). The current (Ix = 1μA) from the Ohms Converter will develop two volts across an unknown resistance of 2000K ohms (an unknown resistance less than 2000K ohms will develop a voltage proportionately less than two volts). The voltage applied to the A-D Converter is also applied to the positive input of U1. The output and negative input of U1 will increase to match the voltage applied to the positive input. This action will maintain a constant current through the Ro + 10K resistor network to insure that the voltage drop across Rx is directly proportional to the resistance.

3-29. A five volt maximum output for an overrange input or for open input leads is controlled by Q11, Q12, and Q13. As the voltage drop across Rx approaches five volts Q13 will start to conduct turning on Q12. As Q12 starts to conduct it supplies part of the current flow through Q3 to the

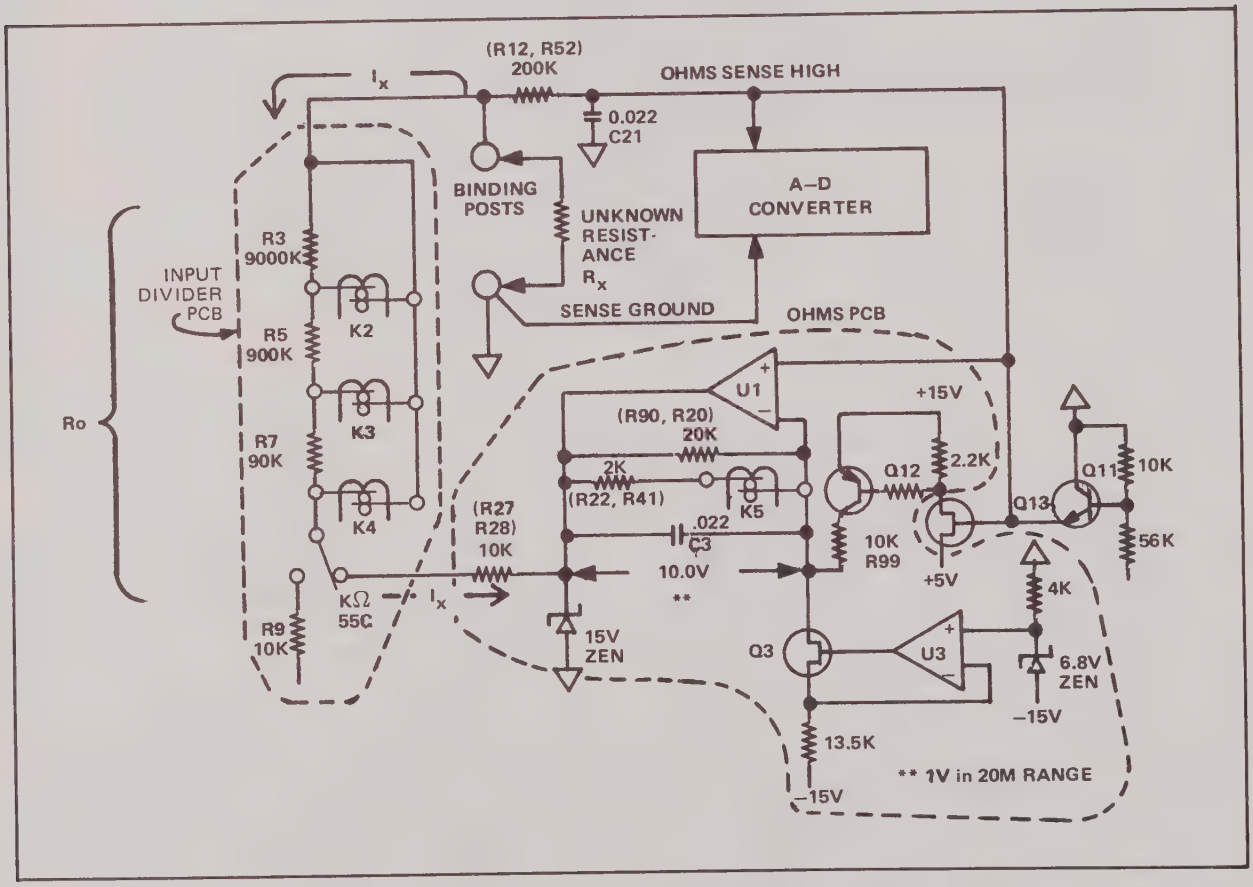

Figure 3-3. OHMS CONVERTER BLOCK DIAGRAM

Table 3-1. OHMS CONVERTER OPERATING CONDITIONS

8600A RANGE	Ro	Ro + 10KΩ	Ix	Rx Max.	RANGE RELAY				A–D RANGE
					K2	K3	K4	K5	
20MΩ	9990KΩ	10,000KΩ	0.1μA	20MΩ				X	2V
2000KΩ	9990KΩ	10,000KΩ	1μA	2000KΩ					2V
200	990KΩ	1,000KΩ	10μA	200KΩ	X				2V
20	90KΩ	100KΩ	100μA	20KΩ		X			2V
2	0Ω	10KΩ	1000μA	2KΩ			X		2V
200Ω	0Ω	10KΩ	1000μA	200Ω			X		0.2V

−15 volt supply. The current flow through the Input Divider resistor network is maintained at a level that will produce a maximum of five volts across the open input leads.

3-30. AC CONVERTER

3-31. The AC Converter produces a dc output voltage proportional to the ac input voltage. Table 3-2 presents the relay conditions for each ac volts range; relay K4 is located on the Input Divider pcb and closes to apply the AC Converter output to the A-D Converter . Figure 3-4 is a simplified circuit diagram of the AC Converter.

3-32. The ac volts input is capacitively coupled across C1 through input impedence resistor R17 to the inverting input of amplifier Q1, U2. The gain of the amplifier is determined by the ratio of the feed-back resistance, as selected by range relays K6, K7, and K8, to the input resistor R17. The amount of alternating current at the junction of CR11 and CR12 is therefore proportional to the level of the ac input voltage. One half of the alternating current passes through CR12 to develop a dc voltage level at the input of the Low Pass (L.P.) Filter. The L.P. Filter then filters the ac signal superimposed on the dc voltage to produce a dc output voltage directly proportional to the ac voltage input. The dc output voltage is then applied to the A-D Converter.

Table 3-2. AC CONVERTER RELAY OPERATION

8600A RANGE	K4	K6	K7	K8	A–D RANGE
1200VAC	X			X	2V
200VAC	X		X		2V
20VAC	X	X			2V
2VAC	X				2V
200mVAC	X				0.2V

3-33. CURRENT SHUNT

3-34. The Current Shunt produces an output voltage (ac or dc) proportional to the current (ac or dc) applied to the input. A schematic diagram of the Current Shunt is located in Figure 7-1.

3-35. The Current Shunt consists of series connected shunt resistors R13, R14, R15, R16, and R2, contacts of range switches S6 through S10, and input protection components F1, CR1, CR2, CR6 and CR8. The input current is applied across a portion of the shunt resistor network via contacts of the selected range switch. The voltage developed by the current flow through the shunt resistance for direct current inputs is applied to the A-D Converter; for alternating current the developed ac voltage is applied to the AC Converter.

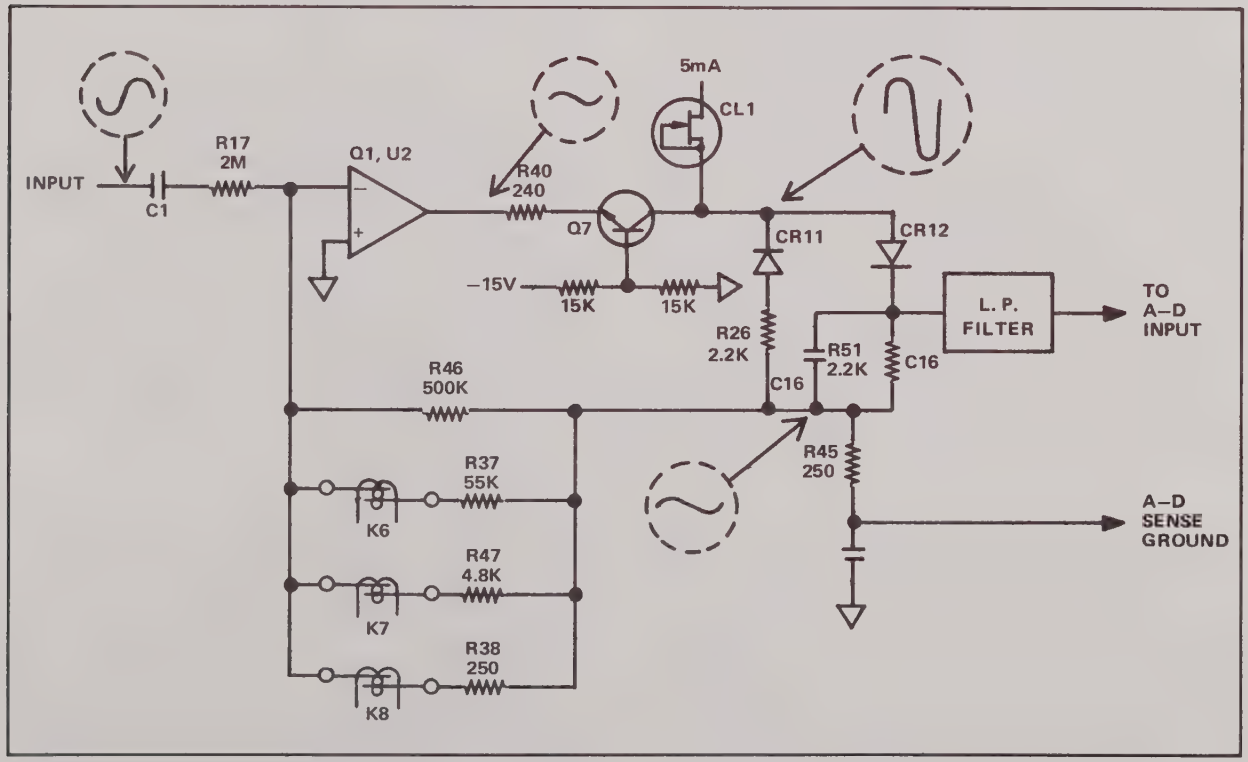

Figure 3-4. AC CONVERTER BLOCK DIAGRAM

3-36. The Current Shunt is not only protected against inputs exceeding two amperes, as provided by fuse F1, it is also protected from possible damage caused by an overrange input. Diodes CR1, CR2, CR6, and CR8 will start to conduct if the voltage drop across the shunt resistors exceeds 1.2 volts.

3-37. A/D Converter

3-38. The A-D Converter uses a dual-slope conversion technique. The dc voltage at the input of the A-D Converter is integrated (charges a capacitor) for a controlled amount of time (100 ms). The level to which the capacitor is charged is directly proportional to the level of dc voltage applied to the input. The charged capacitor is then discharged at a controlled rate so that the discharge time is proportional to the level of charge on the capacitor. The discharge time is measured by counting the number of cycles of a reference frequency that occur from the start of discharge to the point where the capacitor reaches a selected zero detect level. Figure 3-5 is a basic illustration of the A-D Converter. The Input Divider is shown as the A-D Converter input voltage source.

3-39. The dc voltage output of the Input Divider is gated through Q14 to the A-D Buffer U4 during the 100 ms integrate (INT) control signal. The dc voltage output of U4 is applied to the inverting input of the Integrator U5. The output of U5 charges capacitor C28 for the duration of the INT control signal Q14 is inhibited which inturn stops the charging of C28. If the dc voltage applied to U4 was positive control signal DE (−R) will enable Q21; if negative control signal DE(+R) will enable Q16. Using the negative dc voltage input as an example, the DE(+R) control signal would enable Q16 and apply the +1V REF voltage to the input of U4. The output of U4 is again applied to the inverting input of U5. As U5 conducts it will reduce the charge held by C28 at a set rate. The output of U5 is connected to the inverting input of the Comparator U6. When the charge on C28 (the output of U5) matches the +0.18 mV zero detect level on the positive input of U6 a compare output signal from U6 is sent to U8 in the Control and Display section.

3-40. After the A-D Converter has integrated the unknown input voltage, integrated the reference voltage, and produced the compare output; the circuits of the converter are zeroed for a new measurement. An auto zero (AZ) control signal from U8 will enable Q15 and Q22 to zero the comparator circuits. The AZ control signal will also enable Q17 to charge capacitor C22 to the reference voltage level. This provides the negative reference voltage, when Q21 is enabled, needed to process a positive input voltage.

3-41. The three separate zero detect levels applied to the positive input of U6 provide compensation for the 15 μs transitional period at the end of the INT control signal. The first 15 μs of the reference integration, DE(+R) or DE(−R), the reference frequency is not counted to insure that the transition period does not introduce an error. The zero detect level is changed to compensate for the effect of the 15 μs delay.

3-42. Control and Display

3-43. The control portion of the instrument consists of contacts of the range and function switches, a three-pole-double-throw switch U16, a bipolar ROM U9, and custom integrated circuit U8. The range and function switch positions in conjunction with strobe signal inputs to U16, control the illumination of the polarity indicator on the display and the selection of five or six ranges for the autorange feature. Refer to Figure 7-1 for the schematic diagram of the control circuits.

3-44. The control signals for timing the A-D Converter operation and multiplexing the digit information to the display is developed, by U8, from the 1 MHz output of an oscillator consisting of Y1, U7, and R87. Strobe signals ST2, ST4, ST6, ST1, and ST7 or 0 cause the serially presented digit information to be displayed on the correct significant digit.

3-45. The digital count representing the value of the unknown instrument input is totaled within U8 on decade counters. The bcd equivalent of each decade is individually strobed out of U8 by the same strobe signal that enables the corresponding significant digit of the display. The output is updated during the autozero (AZ) period to reflect the next reading. The digit count on the decade counters plus the strobe signals are used within U8 to create an up range or down range signal. This signal is applied to a range counter that produces the three line (a, b, and c) range command signals used by the bipolar ROM (U9) to energize the range relays in the AC Converter and Input Divider.

4-46. The display consists of a seven segment decoder U10, LED displays U11 through U15, and strobe drivers Q29 through Q39 (see Figure 7-3). The four line (W, X, Y, Z) digit information output from U8 is connected to the seven segment decoder. The output of the decoder is applied in parallel to all display LEDs. The strobe signal will enable the LED that corresponds to the significant digit applied to the decoder. If the 20MΩ or the 200mV-200μA-200Ω range is selected, the respective control line from U8 will illuminate CR3 or CR4.

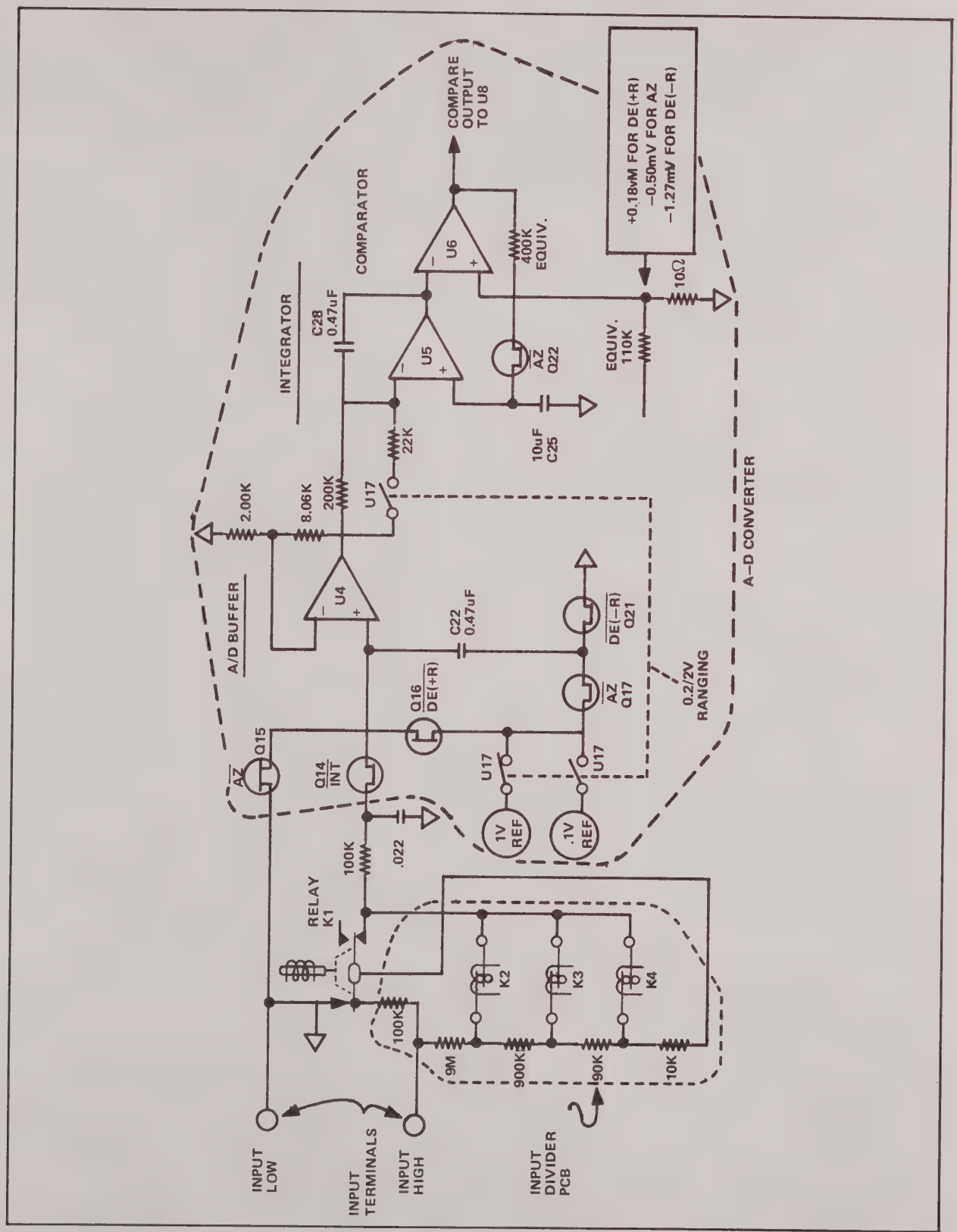

Figure 3-5. A/D CONVERTER BLOCK DIAGRAM

Section 4
Maintenance

4-1. INTRODUCTION

4-2. This section of the manual contains information concerning maintenance and servicing of the Model 8600A Digital Multimeter. A calibration interval of 90 days is recommended to insure instrument operation within the 90-day specifications. Test equipment recommended for performance tests, calibration adjustments and troubleshooting is listed in Table 4-1. If the recommended equipment is not available, equipment of equivalent specifications may be used.

4-3. SERVICE INFORMATION

4-4. Each instrument manufactured by the John Fluke Mfg. Co., Inc. is warranted for a period of one year upon delivery to the original purchaser. The WARRANTY is printed on the back of the title page located at the front of the manual.

4-5. Factory authorized calibration and service for each Fluke product is available at various world wide locations. A complete list of these Technical Centers is included with the WARRANTY. Shipping information is given in Section 2 of this manual. If requested, an estimate will be provided to the customer before any repair work is begun on instruments that are beyond the warranty period.

Table 4-1. REQUIRED TEST EQUIPMENT

NOMENCLATURE	MINIMUM USE SPECIFICATIONS	RECOMMENDED EQUIPMENT
AC Calibrator	Voltage Range: 0 to 1000V ac Frequency Range: 30Hz to 100 kHz Voltage Accuracy: 30 Hz to 50 Hz..... 0.05% 50 Hz to 10 kHz..... 0.02% 10 kHz to 100 kHz... 0.05%	John Fluke Model 5200A and 5205A
DC Calibrator	Voltage Range: 0 to 100V dc Accuracy: ±0.003%	John Fluke Model 3330B
DC Current Calibrator	Current Range: 0 to 2 mA Accuracy: 0.006%	John Fluke Model 3330B
DC Current Calibrator	Current Range: 2 mA to 2A Accuracy: 0.02%	John Fluke Model 382A
Digital Multimeter	Voltage Accuracy: 0.1% Input Impedance: 1000MΩ	John Fluke Model 8600A
Resistor Decade	Resistance Accuracy: ±0.01%	ESI 1063B
Oscilloscope	General Purpose with 10 MΩ probe	Tektronix 465

4-6. GENERAL MAINTENANCE

4-7. Access/Disassembly

4-8. Use the following procedure to gain access to the interior of the 8600A.

a. With the power switch in the OFF position, disconnect the line cord.

b. Remove the Phillips screw from the rear of the instrument case.

c. Remove the instrument from the case.

4-9. The ohms converter, ac converter and input divider printed circuit boards can be removed from the main board. The ohms converter and input divider boards can be removed by pulling them straight up from the main board until they are free of the connector pins. The ac converter, however, must be removed with care because of a wire connection to the ACMA switch. When the ac converter is free of the connector pins it should then be held to one side so the buss wire can be disconnected.

NOTE!

When reinstalling the plug in boards, insure that all connector pins are properly aligned before seating the board.

4-10. Cleaning

4-11. Clean the instrument periodically to remove dust, grease and other contamination. Use the following procedure:

a. Clean the interior with clean, dry air at low pressure (20 psi). The contaminates on printed circuit boards can first be loosened by spraying them with Freon T.F. Degreaser (MS 180), then removed with low pressure air.

b. Clean the front panel and exterior surfaces with anhydrous ethyl alcohol or a soft cloth dampened with a mild solution of detergent and water.

4-12. Fuse Replacement

4-13. The power fuse (F2) is located on the main printed circuit board near the power transformer. Access to the fuse is accomplished by following the Access/Disassembly procedure found in this section of the manual. If replacement is necessary, use a 1/8 ampere fuse for either 115V ac or 230V ac power configuration (½ ampere fuse for 8600A–01).

4-14. PERFORMANCE TESTS

4-15. The following tests are intended for use in performance testing of the 8600A. The tests compare the instrument performance to the accuracy specifications and are especially suited to acceptance testing of new instruments. Tests should be conducted under the following conditions: ambient temperature 23°C ±5°C, relative humidity less than 80%.

NOTE!

Tolerances and test limits for performance tests are derived from the 90-day instrument specifications.

4-16. DC Voltage Test

4-17. Using the dc voltage calibrator, sequentially apply the voltages indicated in Table 4-2 to the 8600A V-Ω input terminals and select the ranges prescribed. The 8600A should display a reading within the indicated limits.

4-18. Ohms Test

4-19. Using the resistor decade, sequentially apply the resistance values indicated in Table 4-3 to the 8600A V-Ω input terminals, and select the ranges prescribed. The 8600A should display a reading within the indicated limits.

Table 4-2. DCV PERFORMANCE TEST

8600A RANGE	INPUT REQUIRED	8600A DISPLAY LIMITS
200mV	+190.00mV	+189.90 to 190.10mV
200mV	–19.000mV	–18.97 to 19.03mV
2V	+1.9000V	+1.8995 to 1.9005V
2V	–1.9000V	–1.8995 to 1.9005V
2V	+ .9000V	+.8997 to .9003V
20V	+19.000V	+18.995 to 19.005V
20V	–19.000V	–18.995 to 19.005V
200V	+190.00V	+189.95 to 190.05V
1200V	+1000.0V	+999.7 to 1000.3V
AUTO	– .17000V	–169.91 to 170.09mV
AUTO	–1.7000V	–1.6996 to 1.7004V
AUTO	–17.000V	–16.996 to 17.004V
AUTO	–170.00V	–169.96 to 170.04V
AUTO	–1000.0V	–999.7 to 1000.3V

Table 4-3. OHMS PERFORMANCE TEST

8600A RANGE	INPUT REQUIRED	8600A DISPLAY LIMITS
AUTO	SHORT	00.00 to 00.03
AUTO	100.00Ω	99.87 to 100.13
AUTO	1.0000kΩ	.9989 to 1.0011
AUTO	10.000kΩ	9.994 to 10.006
AUTO	100.00kΩ	99.94 to 100.06
AUTO	1000.0kΩ	999.4 to 1000.6
AUTO	10.000MΩ	9.979 to 10.021
AUTO	OPEN	18.888 Flashing (20MΩ LED lit)

4-20. DC Current Test

4-21. Using the dc current calibrator (check Table 4-1 for correct calibrator) sequentially apply the values of dc current indicated in Table 4-4 to the 8600A MA input terminals and select the ranges prescribed. The 8600A should display a reading within the indicated limits.

Table 4-4. DC CURRENT PERFORMANCE TEST

RANGE	INPUT	READING
200 μA	Open	–00.05 to +00.05
200 μA	+190.00 μA	+189.79 to +190.21
2 mA	+1.9000 mA	+1.8979 to +1.9021
20 mA	+19.000 mA	+18.979 to +19.021
200 mA	+190.00 mA	+189.79 to +190.21
2000 mA	+1.9000 A	+1897.9 to +1902.1

NOTE!

Because the current measurements of ac and dc are made using the same shunt resistors; a check of ac current is not made.

4-22. AC Voltage Test

4-23. Using the ac voltage calibrator, apply the ac voltages indicated in Table 4-5 to the 8600A V-Ω input terminals and select the ranges prescribed. The 8600A should display a reading within the indicated limits.

4-24. CALIBRATION

4-25. Introduction

4-26. The 8600A should be calibrated every 90 days or whenever repairs have been made, to insure the instrument continues to operate at its rated accuracy. The calibration should be performed under the following environmental conditions; ambient temperature of 23°C ±5°C and a relative humidity of less than 80%. Refer to Table 4-1 for the recommended test equipment. Calibration adjustment locations are pictured in Figure 4-1. Perform the following preliminary steps before calibrating the instrument.

a. Remove the instrument from the case.

b. Connect the 8600A to the appropriate (115V ac or 230V ac) line power.

c. Turn the instrument on and allow it to warm-up for a minimum of 15 minutes.

d. Insure that the ac and dc calibrators are up to their normal operating temperatures.

NOTE!

Use only non-metalic adjustment tools.

Table 4-5. ACV PERFORMANCE TEST

8600A RANGE	INPUT REQUIRED	FREQUENCY Hz	8600A DISPLAY LIMITS
200 mV	190.00 mV	70 kHz	188.05 to 191.95 mV
200 mV	190.00 mV	500 Hz	189.46 to 190.54 mV
200 mV	39.00 mV	30 kHz	38.60 to 39.40 mV
2 V	1.9000 V	500 Hz	1.8959 to 1.9041 V
2 V	.9000 V	500 Hz	.8979 to .9021 V
2 V	1.9000 V	50 kHz	1.8900 to 1.9100 V
2 V	1.9000 V	100 kHz	1.8800 to 1.9200 V
2 V	1.0000 V	30 Hz	.9945 to 1.0055 V
20 V	19.000 V	500 Hz	18.959 to 19.041 V
20 V	19.000 V	70 kHz	18.800 to 19.200 V
200 V	190.00 V	500 Hz	189.59 to 190.41 V
200 V	100.00 V	30 kHz	99.45 to 100.55 V
1200 V	1000.0 V	500 Hz	996.9 to 1003.1 V
1200 V	1000.0 V	20 kHz	994.0 to 1006.0 V

4-27. DC Volts Calibration

4-28. The calibration procedure for the DCV FUNCTION of the 8600A is presented in Table 4-6. Use the recommended dc voltage calibrator (see Table 4-1) to apply the prescribed dc voltages to the V-Ω INPUT terminals and, where required, make the adjustments to meet the specified display limits.

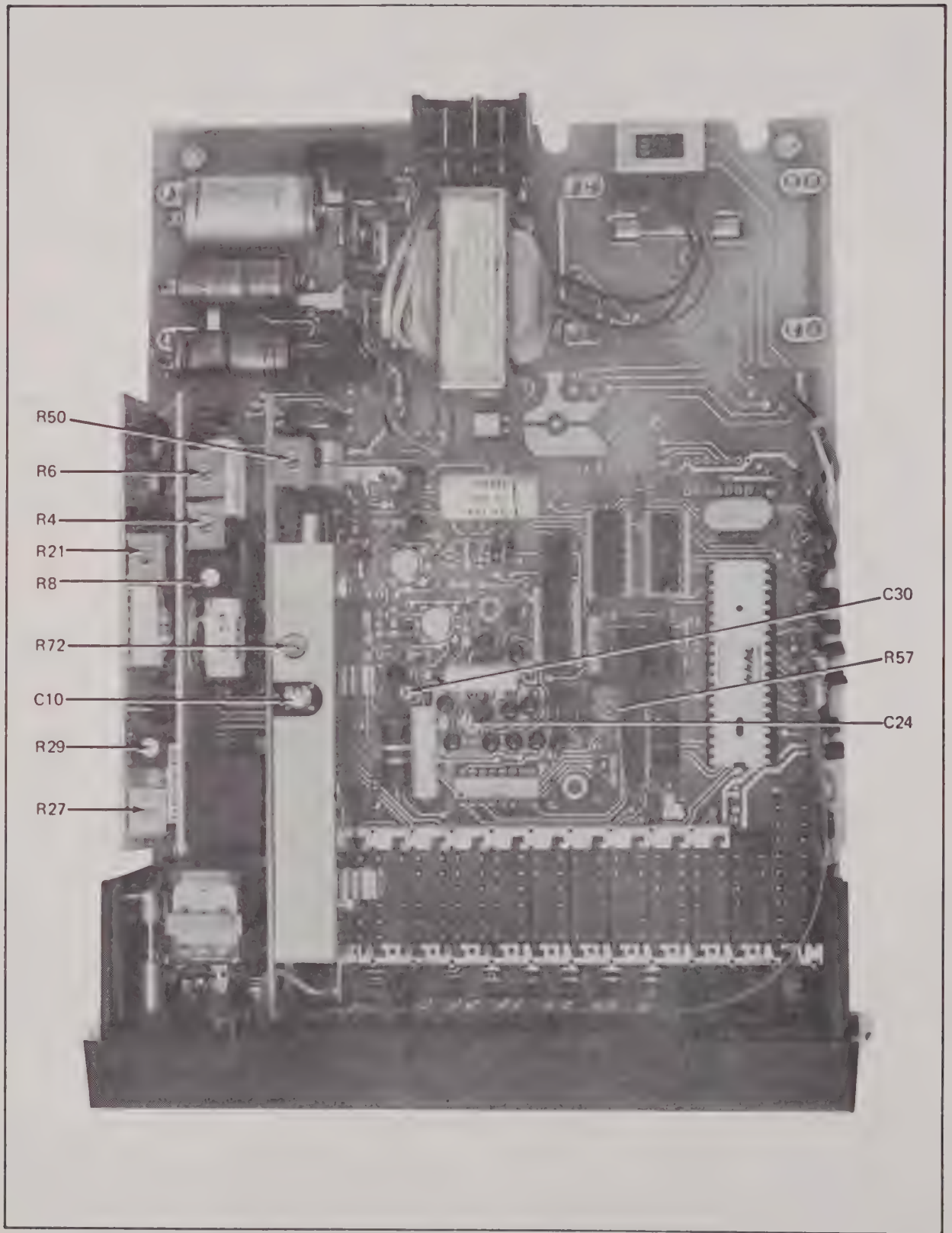

Figure 4-1. CALIBRATION ADJUSTMENT LOCATIONS

Table 4-6. DC VOLTS CALIBRATION PROCEDURE

STEP	8600A RANGE	INPUT REQUIRED	ADJUSTMENT	8600A DISPLAY LIMITS
1	Select the VDC FUNCTION switch on the front panel.			
2	200mV	Short	none	–00.01 to +00.01
3	200mV	1MΩ*	C24	–00.01 to +00.01
4	200mV	+.19V	none	note display reading
5	200mV	–.19V	C30	within 1 digit of step 4 display
6	(Repeat steps 3, 4, and 5 until each step is within limits)			
7	20V	open	none	±00.00 to +00.61
8	2V	+1.9000V	R57	+1.8999 to +1.9001
9	2V	–1.9000V	R57	–1.8999 to –1.9001
10	(Repeat steps 8 and 9 until both are within limits)			
11	2V	+0.9000V	none	+0.8999 to +0.9001
12	200mV	+190.00mV	none	+189.95 to +190.05**
13	200mV	–190.00mV	none	–189.95 to –190.05**
14	20V	+19.000V	R4	+18.999 to +19.001
15	20V	–19.000V	R4	–18.999 to –19.001
16	(Repeat steps 14 and 15 until both are within limits)			
17	200V	+190.00V	R6	+189.99 to +190.01
18	1200V	+1000.0V	R8	+999.9 to +1000.1

* Place a 1MΩ resistor across the V-Ω INPUT.
** 200mV LED on the display should be on.

4-29. Ohms Calibration

4-30. The calibration procedure for the KΩ function of the 8600A is presented in Table 4-7. Use the recommended resistor decade (see Table 4-1) to apply the prescribed resistances to the VΩ INPUT terminals and, where required, make the adjustments to meet the specified display limits.

CAUTION!

Remove any applied voltage from the 8600A input terminals before starting the Ohms Calibration.

4-31. AC Volts Calibration

4-32. The calibration procedure for the ACV FUNCTION of the 8600A is presented in Table 4-8. Use the recommended ac voltage calibrator (see Table 4-1) to apply the prescribed ac voltages at the indicated frequencies to the VΩ INPUT terminals and, where required, make the adjustments to meet the specified display limits.

4-33. TROUBLESHOOTING

4-34. The following information is provided to assist in locating malfunctions in the 8600A. It is recommended that the theory of operation in Section 3 be read completely before attempting to troubleshoot the instrument.

Table 4-7. OHMS CALIBRATION PROCEDURE

STEP	8600A RANGE	INPUT REQUIRED	ADJUSTMENT	8600A DISPLAY LIMITS
1	Depress the KΩ FUNCTION switch on the front panel.			
2	200	Short	none	0.00 to 00.02
3	2000kΩ	1000.0kΩ	R21	999.9 to 1000.1
4	2	1.0000kΩ	R27	.9999 to 1.0001
5	20MΩ	10.000MΩ	R29	9.997 to 10.003MΩ

Table 4-8. AC VOLTS CALIBRATION PROCEDURE

STEP	8600A RANGE	INPUT VOLTAGE REQUIRED	INPUT FREQUENCY REQUIRED	ADJUSTMENT	8600A DISPLAY LIMITS
1	Simultaneously select the ACMA and DCV FUNCTION switches. *				
2	1200V	none	none	R40	–20.0 to –30.0
3	Select the VAC FUNCTION switch on the front panel.				
4	2	1.9000V	500Hz	R50	1.8998 to 1.9002
5	2	0.9000V	500Hz	none	.8997 to .9003
6	200	190.00V	500Hz	none	189.90 to 190.10
7	200	190.00V	50kHz	C2	189.95 to 190.05
8	2	1.9000V	50kHz	C19	1.8995 to 1.9005
9	Repeat steps 7 and 8 until both are within limits				
10	2	1.9000V	100kHz	none	1.8875 to 1.9125
11	2	1.9000V	30Hz	none	1.8950 to 1.9050
12	20	19.000V	500Hz	none	18.990 to 19.010
13	20	19.000V	50kHz	C10	18.990 to 19.010
14	200mV	190.00mV	50kHz	none	189.80 to 190.20**
15	200mV	190.00mV	500Hz	none	189.85 to 190.15**
16	200mV	39.00mV	500Hz	none	38.90 to 39.10**
17	1200V	1000.0V	500Hz	none	998.0 to 1002.0
18	1200V	1000.0V	20kHz	none	996.0 to 1004.0

* Simultaneous selection of both function switches connects the positive 25mV AC Converter offset to the A-D Converter auto zero input. The A-D Converter action causes the negative display of STEP 2.

** 200MV LED on the display should be on.

4-35. Initial Troubleshooting

4-36. The troubleshooting techniques given below should be completed as the first step toward repairing any apparent malfunction in the unit. Improper operation may not always be caused by failures within the 8600A. The following reminders of basic fault isolation techniques will help determine if the cause is the result of an internal failure or faulty external connection.

a. Carefully check the 8600A control settings: some false indications may be caused by an incorrect or overlooked control setting.

b. Check associated equipment: insure that associated equipment controls and connections are correct.

c. Check the 8600A performance: the performance test (par. 4-14) will determine if the malfunction is in the 8600A.

d. Carefully inspect the interior of the instrument: check for physically damaged parts, lose or broken wires, and improperly seated plug-in assemblies.

4-37. When it has been determined by the above checks that the malfunction is within the 8600A multimeter, the following procedure should be used to isolate the problem area. The recommended test equipment for troubleshooting this instrument is listed in Table 4-1.

4-38. Power Supply Checks

4-39. Incorrect output voltages from the +5 volt, +15 volt, or –15 volt supplies may cause the unit to exhibit various improper indications. Because of this the power supplies should be checked in the event of any 8600A malfunction. Use the following procedure to check the power supply output voltages.

a. Connect the test equipment multimeter return lead to the V-Ω LOW input terminal.

b. Connect the high input lead to TP12 the +5 volt supply. The power supply voltage should be +4.75V to +5.75.

c. Connect the high input lead to TP4 the −15 volt supply. The power supply voltage should be −15.0 ±0.5 volts.

d. Connect the high input lead to TP5 the +15 volt supply. The power supply voltage should be +15.0 ±0.5 volts.

4-40. Fault Area Isolation

4-41. A malfunction in the 8600A may be isolated to a particular section of the circuitry by observing the front panel display during each mode of operation. The performance test (par. 4-14) will exercise the 8600A in each function in order to determine the functional operations of the unit affected by the failure.

4-42. The indications observed during the 8600A operation in each of four functions (VDC, VAC, Ohms, and DC current) may isolate the failure to a particular area. Table 4-9 lists the fault area indicated by various combinations of proper or improper 8600A operation in each of the four functions exercised in the performance test.

4-43. Troubleshooting information for the indicated fault area is presented in the following paragraphs. Proceed to the troubleshooting information for the indicated failure area. It should be kept in mind that some failures may cause improper operation of functional areas other than the one actually containing the problem.

4-44. INPUT DIVIDER

4-45. Failures within the input divider that would only be detectable in the VDC function will generally be limited to out-or-tolerance resistors or improper VDC switch contacts or reed relay contacts.

4-46. OHMS CONVERTER

4-47. An instrument malfunction affecting only the ohms mode of operation is generally the result of the ohms converter producing an improper level of current for the particular resistance range being used. The following procedure should be used to evaluate the operation of the ohms converter.

a. Select the KΩ function and 20 K range.

b. Place a good quality short across the V-Ω input terminals.

c. Measure the voltage level at the cathode of CR2. It should be +10 ±0.1V dc.

d. If the voltage is incorrect measure the voltage at pin 3 of U1. This point should be 0.00 volts ±100 microvolts.

e. A voltage level greater than ten volts at CR2 and zero volts at pin 3 of U1 would indicate that the current source (Q3, U3 and associated components) is supplying more current than normal. If the voltage at CR2 were less than ten volts the current from Q3 would probably be less than normal.

4-48. The operation of the current source can be checked by measuring the voltage at pins 2 and 3 of U3. The voltage on both pins should be approximately −8.6 volts. Uneven voltages may be caused by improper resistance value of R35 or R91, or a failure in CR10. The voltages at pin 2 and 3 of U3 may be proper and the current supply from Q3 improper if the gate of Q3 were leaking current back to pin 6 of U3.

Table 4-9. FAULT AREA INDICATION

8600A FUNCTION	8600A OPERATION – PROPER OR IMPROPER				
VDC	IMPROPER	PROPER	PROPER	PROPER	IMPROPER
OHMS	IMPROPER	IMPROPER	PROPER	PROPER	IMPROPER
DCI	PROPER	PROPER	IMPROPER	PROPER	IMPROPER
VAC	PROPER	PROPER	PROPER	IMPROPER	IMPROPER
FAULT AREA INDICATED	INPUT DIVIDER	OHMS CONVERTER	CURRENT SHUNT	AC CONVERTER	A/D CONVERTER OR CONTROL AND DISPLAY

4-49. CURRENT SHUNTS

4-50. Failures in the current mode of operation affecting all current ranges would probably be attributed to a failure in one of the following areas: 1) the input fuse (F1) open, 2) one or more of diodes CR1, CR6, CR7, or CR8 shorted, or 3) improper connection in the contacts of function switch S2 (ACI), or S4 (DCI) or range switches S6-S10.

4-51. AC CONVERTER

4-52. Generally a failure in the ac converter will do one of two things: 1) create a dc voltage output without an ac input signal applied to the 8600A input terminals or 2) not produce the proper dc voltage output when an ac input is applied to the unit. A dc offset voltage created within the ac converter will cause the multimeter display to indicate some substantial value of ac voltage when a short is placed across the input terminals. When the ac converter failure causes the display to remain at zero when an ac signal is applied to the input, the converter is not producing the proper dc voltage output for the A/D converter.

4-53. The operation of the ac converter can be checked for the dc voltage offset by performing the following procedure.

a. Remove the molded plastic outer case from the 8600A (see par. 4-7 Access/Dissassembly).

b. Remove the ac converter pcb, take the metal shield off the side and reinstall the board into mainframe.

NOTE!

Take care that all the connector pins on the board are properly aligned before seating the pcb.

c. Short the V-Ω INPUT terminal HI to LO. Select the 200 RANGE and VAC FUNCTION.

d. Connect the return lead of the test equipment voltmeter to the 8600A V/Ω LO input terminal.

e. Connect the high input lead to the ac converter output at pin 9. Note the voltage level.

f. Move the high input lead to pin 10. The voltage level should be the same as that noted in step d.

4-54. A difference in voltage levels between the two pins would be displayed as an offset on the front panel readout. The level at either pin should not exceed +30 millivolts nor be less than +20 millivolt. If the voltage level is to high or there is a difference in voltage level between the two, check current source CL1 or transistors Q1, Q7, and Q9, or capacitors C12 and C13.

4-55. The operation of the ac converter with an ac input applied, observed at the circuit locations described below, may indicate the fault area. With the 8600A in the 2V range and AC V function apply a 1V rms 500 Hz signal to the V/Ω INPUT terminals and proceed as described below.

a. Connect the input return lead of an oscilloscope to the 8600A MA LO terminal.

b. Connect the scope input probe to the ac converter input at the wire connection on S2A. Note the amplitude of the signal; it should be 2.8 volts peak-to-peak.

c. Move the scope input probe to U2 pin 6. The ac signal at this point should be about one-quarter of the amplitude of the input signal, or about 0.7 volts peak-to-peak. If correct go to step e.

d. If the signal is not present at this point or the dc voltage level is close to either the −15 volt or +15 volt supply, U2, Q7, or CL1 are probably defective. If the signal is distorted check the operation of Q1.

e. Connect the scope input probe to the base of Q8; the signal here should be one-quarter of the amplitude of the input signal. If correct proceed to step g.

f. An improper signal at Q8 may be caused by a failure of either Q8 or Q9. A failure in CL1 or Q7 should affect both the signal at Q8 and the signal at U2 pin 6.

g. The ac converter output at pin 9 should be one volt dc plus the dc voltage offset level at pin 10.

4-56. A/D CONVERTER OR CONTROL AND DISPLAY

4-57. An A/D converter or control and display failure will generally affect the operation of the 8600A in all functions. The exceptions to this would be a malfunction in an individual function's control signal or range relay signal. The following information is provided to aid in isolating problems within the A/D converter and control and display circuitry.

4-58. The A/D converter operation can be checked by observing the output at TP2. Use the following procedure to observe the A/D converter output signal.

a. Select the VDC function and the 2 volt range.

b. Apply +1 volt dc to 8600A V/Ω input terminals.

c. Connect the oscilloscope input return to the MA LO input terminal and the scope input probe to TP 2.

d. The signal at TP2 should be as shown in Figure 4-2.

4-59. The stable +5 volt section of the waveform shown in Figure 4-2 should be 200 ms long for a +1 volt dc input to the 8600A. If the dc input voltage is increased to full scale (2 volts dc) the stable +5 volt portion of the waveform should increase to 300 ms. If the output at TP2 is correct the problem is in the control and display section, proceed to paragraph 4-60. If the waveform is incorrect the waveforms provided in Figure 4-3 should help isolate the malfunction. The waveforms are given for both positive and negative inputs. The connection point in the circuitry is given at the left of each waveform.

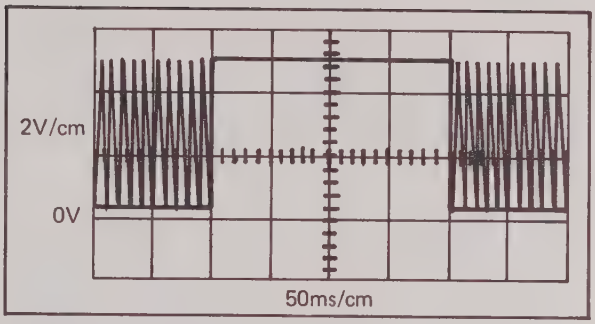

Figure 4-2. A/D CONVERTER OUTPUT SIGNAL

4-60. The digit information to be presented on the front panel is delivered by the custom integrated circuit (U8) in bcd format.

4-61. A malfunction caused by the display section of the circuitry will generally cause the 8600A display to indicate the failure in one of five ways; 1) all LED's are dark, 2) one segment of any one or all LED displays are dark, 3) any single LED display is dark, 4) the numbers containing a particular binary code (1, 2, 4 or 8) will not display or 5) one digit is brighter than normal and all others are off. The probable cause for each possible failure indication is given below.

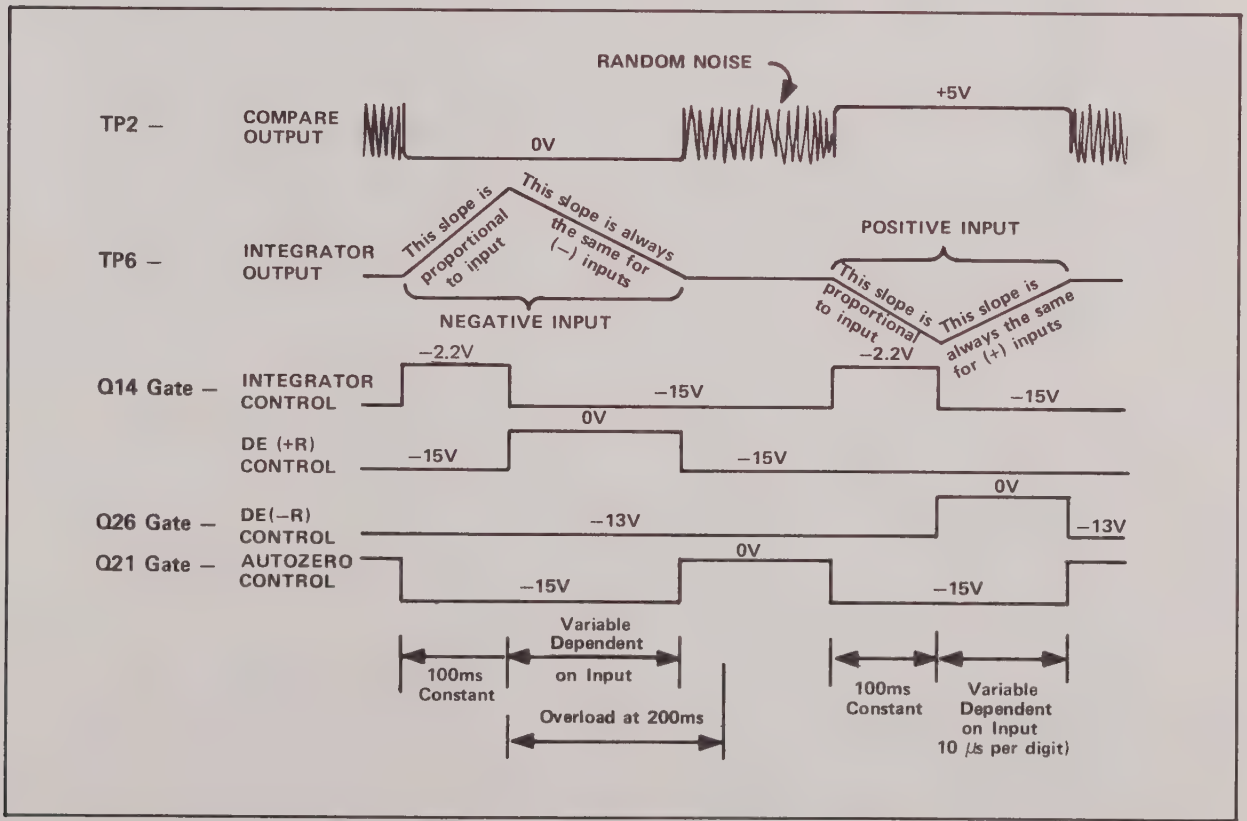

Figure 4-3. A/D CONVERTER CONTROL SIGNALS

4-62. When all LED's are dark, check for +5 volts at the emitter of Q30. Using an oscilloscope check U10 pins 9 through 15, LED segment drive signals, for a squarewave signal alternating between +3.5 volts and +0.4 volts.

4-63. When a segment of only one LED is dark the LED is the probable cause of the failure. If, however, the same segment in all LED' s is out the particular segment drive signal, U10 pins 13, 12, 11, 10, 9, 15, or 14 corresponding to segments A, B, C, D, E, F, and G respectively, can be checked for the required voltage change from +3.5 volts to +0.4 volts as the segment lights.

4-64. When one digit in the display remains dark the strobe signal for that digit should be checked. The base of Q37 (MSD), Q29 (2SD), Q31 (3SD), Q33 (4SD) and Q35 (LSD) should go to +5 volts as each is strobed on for 300μs.

4-65. When the display indicates that one of the binary codes (1, 2, 4, or 8) is missing; the bcd output from U8 can be observed at pin 31 (1), 32 (2), 33 (4) and 35 (8). The output at each pin should drop from +5 volts to about zero volts when that code is used to produce the digit being displayed. If the bcd information at U8 is correct the probably cause of the failure is U10.

4-66. When one display digit is bright and all others are off, the clock oscillator is the probable cause. Check the operation of U7, U8, and the 1 MHz crystal Y1.

Section 5
Lists of Replaceable Parts

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5-1. INTRODUCTION

5-2. This section contains an illustrated parts breakdown of the instrument. Components are listed alpha-numerically by assembly. Electrical components are listed by reference designation and mechanical components are listed by item number. Each listed part is shown in an accompanying illustration.

5-3. Parts lists include the following information:

a. Reference Designation or Item Number

b. Description of each part

c. Fluke Stock Number

d. Federal Supply Code for Manufacturers. See Appendix A for Code-to-Name list.)

e. Manufacturer's part Number or Type.

f. Total Quantity per assembly or component.

g. Recommended Quantity: This entry indicates the recommended number of spare parts necessary to support one to five instruments for a period of two years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for one year or more at an isolated site, it is recommended that at least one in each assembly in the instrument be stocked. In the case of optional subassemblies, plug-ins, etc. that are not always part of the instrument, or are deviations from the basic instrument mode, the REC QTY column lists the recommended quantity of the item in that particular assembly.

h. Use Code is provided to identify certain parts that have been added, deleted or modified during production of the instrument. Each part for which a use code has been assigned may be identified with a particular instrument serial number by consulting the Use Code Effectifity, paragraph 5-7.

5-4. HOW TO OBTAIN PARTS

5-5. Components may be ordered directly from the manufacturer by using the manufacturer's part number, or from the John Fluke Mfg. Co., Inc. factory or authorized representative by using the FLUKE STOCK NUMBER. In the event the part you order has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions, if necessary.

5-6. To ensure prompt and efficient handling of your order, include the following information.

a. Quantity

b. FLUKE Stock Number

c. Description

d. Reference Designation or Item Number

e. Printed Circuit Board Part Number

f. Instrument model and Serial number

5-7. USE CODE EFFECTIVITY LIST

USE CODE	SERIAL NUMBER EFFECTIVITY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	FINAL ASSEMBLY, MODEL 8600A						
	Front Panel and Main PCB Assembly						
	8600A (Line power only)	365866	89536	365866	1		
	8600A–01 (Battery Power)	366906	89536	366906	1		
	Battery Power Supply PCB Assembly (–01 Option)	366781	89536	366781			
	AC Converter Assembly	373852	89536	373852	1		
	Ohms Converter Assembly	373845	89536	373845	1		
	Input Divider Assembly	365890	89536	365890	1		
U8	IC, 3, 4, 5 Digit, C-MOS, 40 pin	354985	89536	354985	1		
	Case, molded	330076	89536	330076	1		
	Decal, knob	347401	89536	347401	1		
	Decal, name plate	380667	89536	380667	1		
	Handle, molded	330092	89536	330092	1		
	Line card	343723	89536	343723	1		
	Pad, foot	338632	89536	338632	1		

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	FRONT PANEL AND MAIN PCB ASSY. (8600A Line Power)	365866	89536	365866	REF		
	Main PCB Assy. Figure 5-1						
C21	Cap, polystyrene, 0.22uF ±10%, 100V	333823	02799	1PJ223K	1		
C22	Cap, polycarbonate, 0.47uF ±10%, 100V	288860	01281	X463VW04791 W	1		
C23	Cap, cer, 2.7pF ±0.25pF, 100V	363705	80031	2222-631-09278	1		
C24	Cap, var, 0.25 – 1.5pF ±0.25pF, 2000V	218206	72982	530-000	1		
C25, C26, C27, C35	Cap, Ta, 10uF ±20%, 20V	330662	56289	196D106X0020 JA1	4		
C28	Cap, polypropylene, 0.47uF ±10%, 50V	363085	01281	JF86	1		
C31	Cap, cer, 0.001uF ±20%, 3KV/5.25K	105635	56289	29C300	1		
C39	Cap, mylar, 0.01uF ±20%	159996	01281	6634W103-010 W	1		
C101, C102	Cap, elect, 220uF +50/–10%, 40V	178616	25403	ET221X040A01	2		
C103	Cap, elect, 2000uF +100/–10%, 15V	364182	25088	B4101-2200/15	1		
CR1, CR2, CR6, CR8	Diode, Si, 2A, 50V	347559	14099	1N5400	4		
CR9, CR15, CR24	Diode, Si, 150 mA	203323	07910	TD8253	3		
CR14, R56, R60	Zener, reference set	377283	89536	377283	1		
CR101, CR102	Rectifier, bridge, 2 amp, 100V	296509	09423	FB100	2		
F1	Fuse, Slo-Blo, 1/8A	166488	71400	MDL	1		
K1	Relay, Telephone, DPOT	357707	12300	R10E2662-2	1		
L1	Choke, RF, 100uh	111542	99800	1537-76	1		
Q2,Q6	Xstr, Si, PNP	195974	04713	2N3906	2		
Q10, Q26, Q27, Q28	Xstr, Si, NPN	159855	07910	CS23030	4		

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
Q11	Xstr, Si, NPN, Selected	352138	89536	352138	1		
Q13, Q16, Q17, Q21, Q22	Xstr, J-FET, N-channel	357889	21845	F2692	5		
Q14, Q15	Xstr, J-FET, N-channel	357897	21845	F2691	2		
Q23	Xstr, J-FET, N-channel	370072	12040	TYPE KE4393	2		
R1	Res, comp, 100K ±5%, ¼W	148189	01121	CB1045	1		
R2	Res, WW, card, 0.1 ± 0.05%	374611	89536	374611	1		
R10, R11, R83	Res, comp, 470K ±5%, ¼W	188441	01121	CB4745	3		
R12, R52	Res, comp, 100K ±5%, 2W	285056	01121	HB1045	2		
R13	Res, WW, 900 ±0.05%, 1/10W	357483	89536	357483	1		
R14	Res, WW, 90 ±0.05%, 1/10W	357517	89536	357517	1		
R15	Res, WW, 9 ±0.05%, 1/10W	357525	89536	357525	1		
R16	Res, WW, card, 1.0 ± 0.05%	356097	89536	356097	1		
R18	Res, met film, 60.4K ±1%, 1/8W	291419	91637	MFF1-860R4F	1		
R23	Res, met film, 30.1K ±1%, 1/8W	168286	91637	MFF1-830R1F	1		
R24	Res, met film, 90.9K ±1%, 1/8W	223537	91637	MFF1-890R9F	1		
R44	Res, comp, 2.4K ±5%, ¼W	193433	01121	CB2425	1		
R57	Res, var, cer, 500 ±10%, ½W	325613	71450	360T501A	1		
R62, R65, R67	Res, match set, 3 pc	375782	89536	375782	1		
R63, R76	Res, comp, 10K ±5%, ¼W	148106	01121	CB1035	2		
R66	Res, met film, 22.1K ±1%, 1/8W	235234	91637	MFF1-822R12 PORM1PCT	1		
R68	Res, comp, 56K ±5%, ¼W	170738	01121	CB5635	1		
R70	Res, met film, 8.06K ±1%, 1/8W	294942	91637	MFF1-88R061 PORM1PCT	1		

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R71	Res, met film, 2.0K ±1%, 1/8W	235226	91637	MFF1-82R02 PORM1PCT	1		
R74	Res, comp, 4.7M ±5%, ¼W	220046	01121	CB4725	1		
R80	Res, met film, 200K ±1%, 1/8W	261701	91637	MFF1-8204 PORM1PCT	1		
R81	Res, comp, 10 ±5%, ¼W	147868	01121	CB1005	1		
R82	Res, comp, 2.7M ±5%, ¼W	193490	01121	CB2755	1		
R84	Res, comp, 2.2K ±5%, ¼W	148049	01121	CB2225	1		
R87	Res, comp, 4.7K ±5%, ¼W	148072	01121	CB4725	1		
R94	Res, comp, 1K ±5%, ¼W	148023	01121	CB1025	1		
R98	Res, comp, 220 ±5%, ¼W	147959	01121	CB2215	1		
R101	Res, comp, 1.3K ±5%, ¼W	234252	01121	CB1325	1		
R102	Res, comp, 750 ±5%, ½W	108894	01121	EB7515	1		
RN1	Res, network, 15 pc	355610		TYPE 760	1		
S1 thru S13	Switch Assembly, pushbutton	363325	89536	363325	1		
S14	Switch, Slide, DPDT 115/230	376789	89536	376798	1		
T1	Xfmr, power	374264	89536	374264	1		
U4	IC, Op, Amp (yellow dot)	381962	12040	LH0042C	1		
U5	IC, Op, Amp (red dot)	385450	89536	385450	1		
U6	IC, linear, voltage comparator	352195	12040	LM311N8	1		
U7	IC, hex, buffer/conv	355214	04713	MC14009CP	1		
U9	IC, bipolar ROM	376061	01295	SN7488AN	1		
U16	IC, digital, COMOS, 2-channel multiplexer	375808	49671	CD4053AE	1		
U17	IC, digital, C-MOS, quad switch	363838	49671	CD4016AE	1		
U101	IC, voltage regulator	363861	49956	RC4195DN	1		
U102	IC, voltage regulator	355107	12040	LM340T5	1		
XF2	Fuseholder, clip	284984	84613	3621-2			
Y1	Crystal, 1.000 MHz	358069	30148	TYPE 815A	1		
	Connector, post	376574	00779	5166-333-68	24		
	Connector, post	267500	00779	86144-2	7		

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	Contact, fuse	396572	89536	396572	1		
	Panduit, cable tie	172080	06383	SST-1	2		
	Receptacle, power, 3 prong						
	Insulator, receptacle	338624	89536	338624	1		
	Contact, earth common	338640	89536	338640	1		
	Contact, voltage	338657	89536	338657	2		
	Pushbutton, grey	369546	71590	J52305-J31753	12		
	Pushbutton, green	352211	71590	J52305-J71449	1		
	Socket, IC, 14-pin	291542	00779	583527-1	1		
	Socket, IC, 16-pin	291534	00779	583529-1	3		
	Socket, IC, 40-pin	376244	23880	TSA3100-40W	1		
	Socket, relay, 2-poles	376665	77342	27E501	1		
	Strap, relay retainer	381624	77342	P49	1		
	Front Panel Assembly						
	Display PCB Assembly	373860	89536	373860	1		
C38	Cap, cer, 47 pF ±10%, 2kV	282145		AVD3-47±10%	1		
F2	Fuse, fast acting, 2A	376582	71400	AGX	1		
J1	Jack, banana, red	162065	74970	108902	1		
J2, J3	Jack, banana, black	162073	74970	108903	2		
FX2	Fuseholder	345611	89536	345611	1		
	Lens, display	367920	89536	367920	1		
	Panel, moulded	369041	89536	369041	1		
	Decal, panel	375865	89536	375865	1		
	Retainer, neoprene	352484	77969	9109E	2		

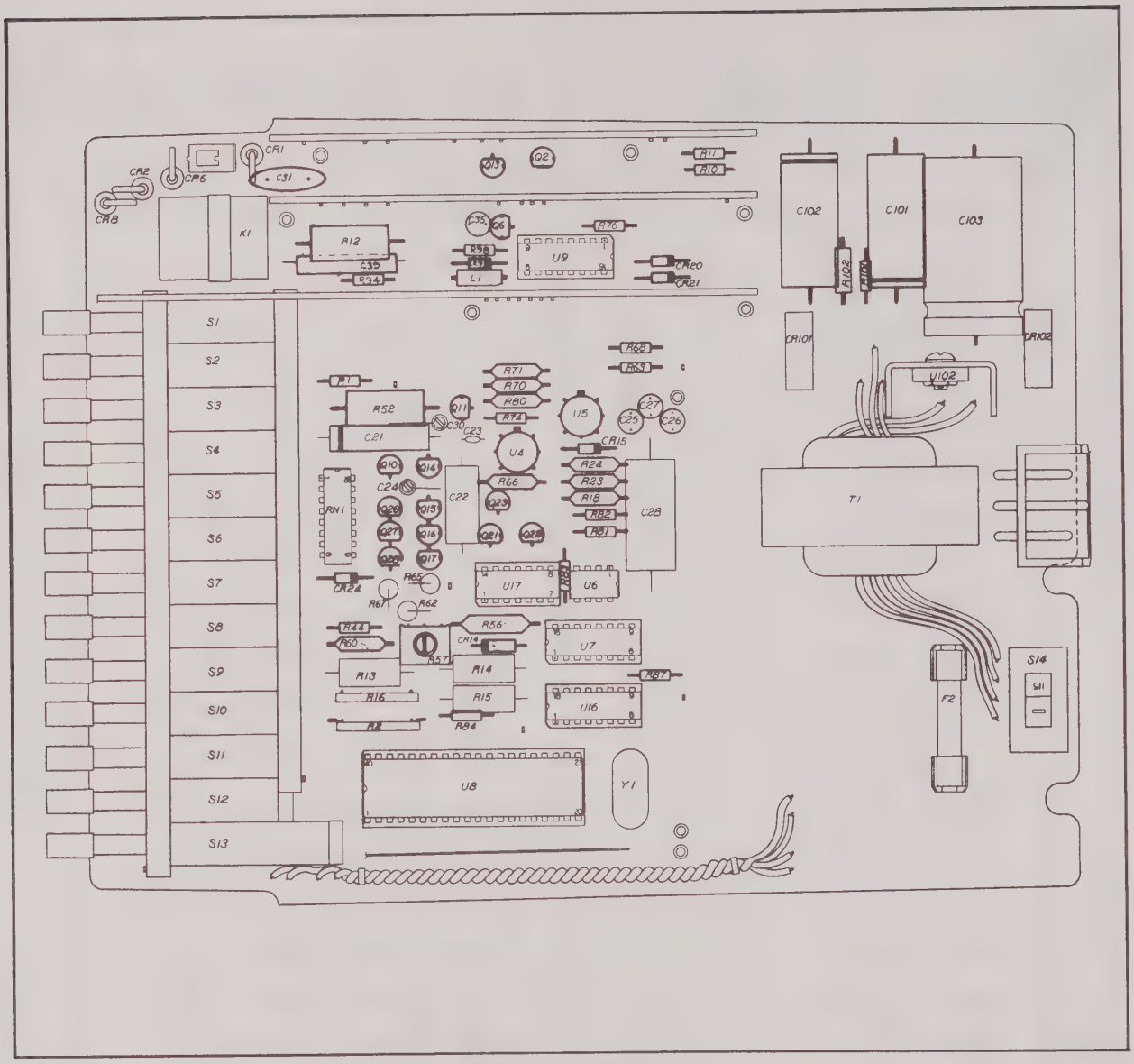

Figure 5-1. FRONT PANEL AND MAIN PCB ASSEMBLY (8600A Line Power)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	FRONT PANEL AND MAIN PCB ASSY (8600A–01 Battery Power)	366906	89536	366906	REF		
	Main PCB Assembly - Figure 5-2						
BT1 thru BT4	Battery Ni-Cad, 1.2V	346924	89536	346924	4		
C21	Cap, polystyrene, 0.022uF ±10%, 100V	333823	01281	863VW22391	1		
C22	Cap, polycarbon, 0.47uF ±10%, 100V	288860	01281	X463VW47491	1		
C23	Cap, cer, 2.7pF ±0.25pF, 100V	363705	80031	2222-631-09278	1		
C24, C30	Cap, var, 0.25 - 1.5pF ±0.25pF, 200V	218206	72982	530-000	2		
C25, C26, C27, C29, C35	Cap, Ta, 10uF ±20%, 20V	330662	56289	196D106X0020 JA1	5		
C28	Cap, polypropylene, 0.47uF ±10%, 20V	363085	01281	JF86	1		
C31	Cap, cer, 0.001uF ±20%, 3KV/5.25KV	105635	56289	29C300	1		
C39	Cap, mylar, 0.01uF ±20%	159996	01281	663UW103-010 W	1		
CR1, CR2, CR6, CR8	Diode, rectifier, Si, 2A, 50V	347559	14099	1N5400	4		
CR9, CR15, CR24	Diode, Si, 150 mA	203323	07910	TD8253	3		
CR14, R56, R60	Zener, reference set	377283	89536	377283	1		
CR21, CR23	Diode, zener	291575	12969	UZ8720	2		
CR201, CR202	Diode, Si, rectifier, 1A, 100V	343491	01295	1N4002	2		
F1	Fuse, Slow blow, ½A	109322	71400	MDL	1		
K1	Relay, telephone, DPDT	357707	12300	R10E2662-2	1		
L1	Choke, rf, 100uH	111542	99800	1537-76	1		

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
L2	Inductor, 6 turn	320911	89536	320911	1		
Q2, Q6	Xstr, Si, PNP	195974	04713	2N3906	2		
Q10, Q26, Q27, Q28	Xstr, Si, NPN	159855	07910	CS23030	4		
Q11	Xstr, Si, NPN, selected	352138	89536	352138	1		
Q14, Q15	Xstr, J-FET, N-channel	357897	21845	F2691	2		
Q16, Q17, Q21, Q22	Xstr, J-FET, N-channel	357889	21845	F2692	4		
R1	Res, fxd, comp, 100K ±5%, ¼W	148189	01121	CB1045	1		
R2	Res, fxd, WW, card, 0.1 ±0.05%	374611	89536	374611	1		
R10, R11, R83	Res, comp, 470K ±5%, ¼W	188441	01121	CB4745	2		
R12, R52	Res, comp, 100K ±5%, 2W	285056	01121	HB1045	2		
R13	Res, WW, 900 ±0.05%, 1/10W	357483	89536	357483	1		
R14	Res, WW, 90 ±0.05%, 1/10W	357517	89536	357517	1		
R15	Res, WW, 9 ±0.05%, 1/10W	357525	89536	357525	1		
R16	Res, WW, card 1 ±0.05%	356097	89536	357525	1		
R18	Res, met film, 60.5K ±1%, 1/8W	291419	91637	MFF1-860R4F	1		
R23	Res, met film, 30.1K ±1%, 1/8W	168286	91637	MFF1-830R1F	1		
R24	Res, met, film, 90.9K ±1%, 1/8W	223537	91637	MFF1-890R9F	1		
R44	Res, fxd comp, 2.4K ±5%, ¼W	193433	01121	CB2425	1		
R57	Res, var, cer, 500 ±10%, ½W	325613	71450	360T501A	1		
R62, R65, R67	Res, matched set, 3 piece	375782	89536	375782	1		
R63, R76	Res, comp, 10K ±5%, ¼W	148106	01121	CB1035	2		
R66	Res, met film, 22.1K ±1%, 1/8W	235234	91637	MFF1-822R12	1		

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R68	Res, comp, 56K ±5%, ¼W	170738	01121	CB5635	1		
R70	Res, met film, 8.06K ±1%, 1/8W	294942	91637	MFF1-88R06	1		
R71	Res, met film, 2K ±1%, 1/8W	235226	91637	MFF1-823PORM1PCT	1		
R74	Res, comp, 4.7M ±5%, ¼W	220046	01121	CB4755	1		
R80	Res, met film, 200K ±1%, 1/8W	261701	91637	MFF1-8	1		
R81	Res, comp, 10 ±5%, ¼W	147868	01121	CB1005	1		
R82	Res, comp, 2.7M ±5%, ¼W	193490	01121	CB2745	1		
R84	Res, comp, 2.2K ±5%, ¼W	148049	01121	CB2225	1		
R87	Res, comp, 4.7K ±5%, ¼W	148072	01121	CB4725	1		
R94	Res, comp, 1K ±5%, ¼W	148023	01121	CB1025	1		
R98	Res, comp, 200 ±5%, ¼W	147959	01121	CB2215	1		
RN1	Res, network, 15 piece	355610	89536	355610	1		
S1 thru S13	Switch, PB altered	390948	89536	390948	1		
T1	Xfmr, power	372033	89536	372003	1		
U4	IC, operational amp, yellow dot	381962	89536	381962	1		
U5	IC, operational amp, red dot	385450	89536	385450	1		
U6	IC, linear voltage comparator	352195	12040	LM811N8	1		
U7	IC, hex, buffer/converter	355214	12040	MC14009CP	1		
U9	IC, bipolar ROM	376061	01295	SN7488AN	1		
U16	IC, digital, C-MOS, 2-channel, multiplexer	375808	49671	CD4053AE	1		
U17	IC, digital, C-MOS, Quad, switch	363838	49671	CD4016AE	1		
XBT	Battery holder	390450	89536	390450	8		
XF1	Fuse holder	103283	71400	4405	1		
Y1	Crystal, 1.000 MHz	358069	30148	TYPE 815A	1		
	Battery polarity label	380675	89536	380675	2		
	Connector, post	379438	00779	86144-5	7		
	Connector, post	376574	00779	5166-333-68	29		
	Contact, battery	344200	89536	344200	8		

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	Contact, fuse	396572	89536	396572	1		
	Rectacle, power, 3 prong						
	Insulator, receptacle	338624	89536	338624	1		
	Contact, earth common	338640	89536	338640	1		
	Contact, voltage	338657	89536	338657	2		
	Pushbutton, grey	369546	71590	J52305-J31753	12		
	Pushbutton, green	352211	71590	J52305-J71449	1		
	Socket, IC, 14 pin	291542	00779	583527-1	1		
	Socket, IC, 16 pin	291534	00779	583529-1	3		
	Socket, IC, 40 pin	376244	23880	TSA3100-40W	1		
	Socket, relay, 2 poles	376665	77342	27E501	1		
	Strap, relay retainer	381624	77342	P49	1		
	Front Panel Assembly						
	Display PCB ASsembly	373860	89536	373860	1		
C38	Cap, cer, 47pF ±10%, 2kV	282145		HVD3 47±10%	1		
F2	Fuse, fast acting, 2A	376582	71400	AGX			
J1	Fack, banana, red	162065	74970	108902	1		
J2, J3	Jack, banana, black	162073	74970	108903	2		
XF2	Fuseholder	345611	89536	345611	1		
	Lens, display	367920	89536	367920	1		
	Panel, moulded	369041	89536	369041	1		
	Decal, panel	375965	89536	375865	1		
	Retainer, neoprene	352484	77969	9109E	2		

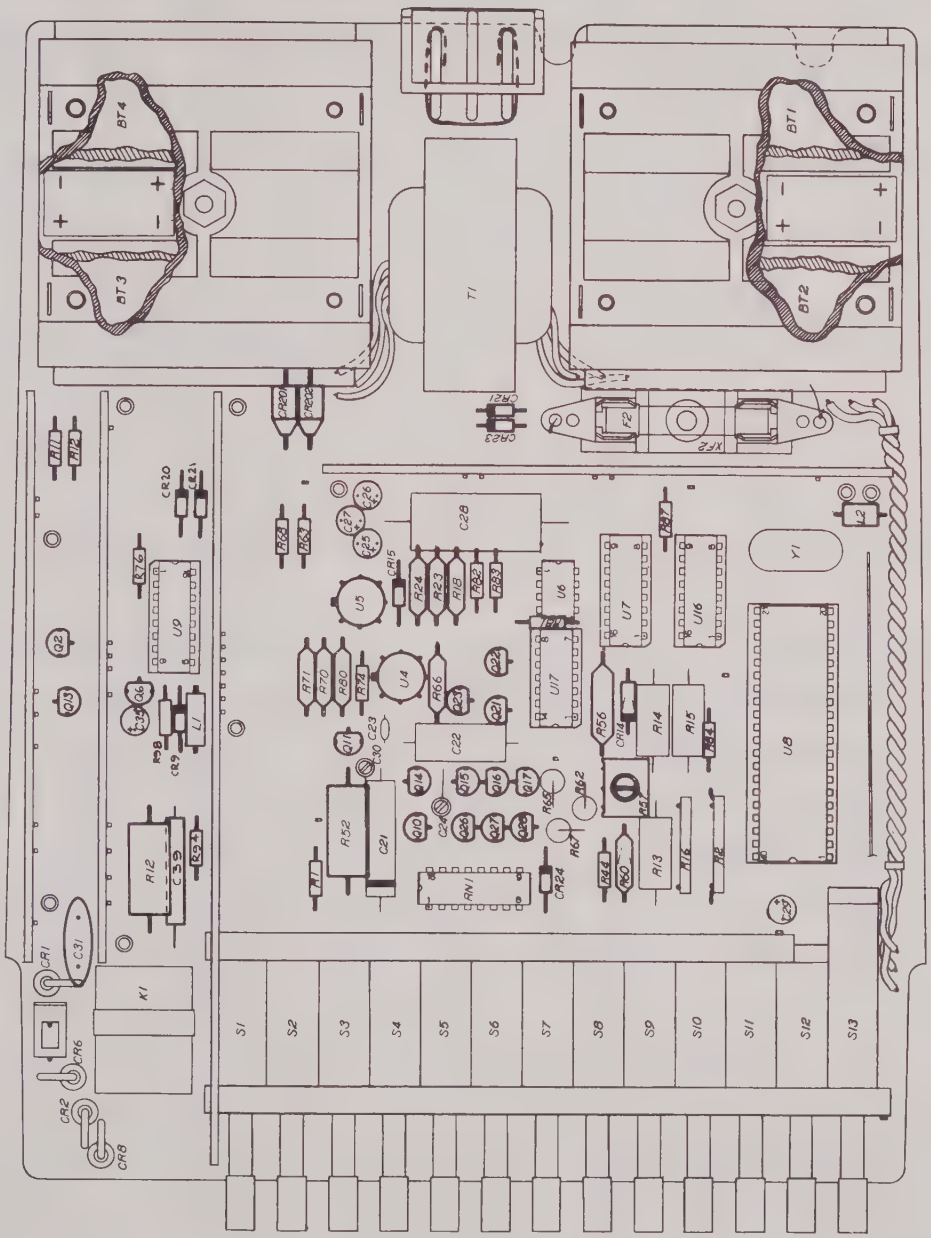

Figure 5-2. FRONT PANEL AND MAIN PCB ASSEMBLY (8600A–01 Battery Power)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	DISPLAY PCB ASSEMBLY	365635	89536	365635	REF		
	Figure 5-3						
CR3, CR4	Diode, light emitting, red	385914		SSL22	2		
Q29, Q31, Q33, Q35, Q37, Q39, Q40, Q41	Xstr, Si, NPN	218396	04713	2N3904	8		
Q30, Q32, Q34, Q36, Q38	Xstr, Si, PNP	340026	07263	MPS6563	5		
Q42	Xstr, Si, PNP	195974	04713	2N3906	1		
R85	Res, comp, 560 ±5%, ¼W	147991	01121	CB5615	1		
R86	Res, comp, 86 ±5%, ¼W	147918	01121	CB8605	1		
RN2	Res, network	381376	89536	381376	1		
U1	IC, TTL, decoder/driver	340109	01295	SN7447AN	1		
U11	Display. LED	380444	50579	DL707-812	1		
U12 thru U15	Display, LED	380436	50579	D707-811	1		

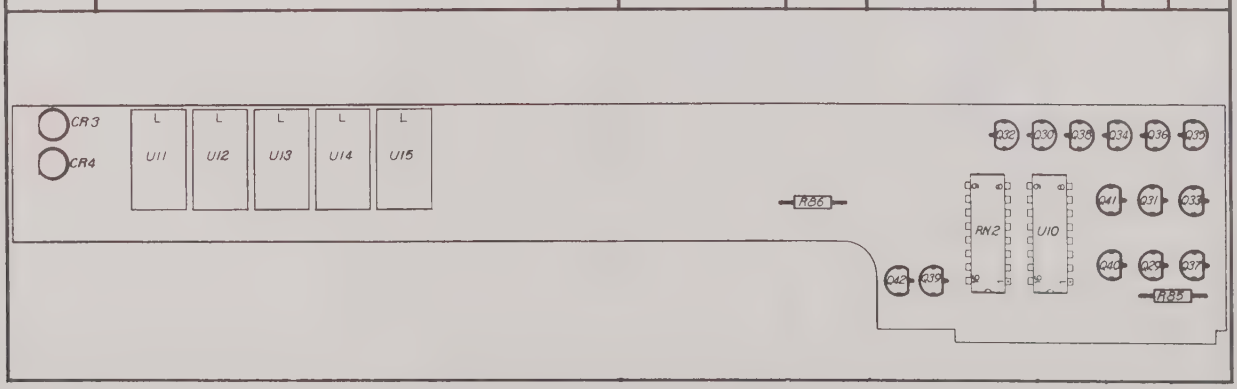

Figure 5-3. DISPLAY PCB ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	BATTERY POWER SUPPLY PCB ASSY (–01 option)	366781	89536	366781	REF		
	Figure 5-4						
C201	Cap, mylar, 5.0uF ±5%, 150V (Used on 115V ac version)	364190	06001	TYPE BA	1		
C201	Cap, mylar 8.0uF ±5%, 135V (Used on 110V ac version)	380261	06001	TYPE BA	1		
C201	Cap, metalized polypropylene 3.3uF ±5%, 300V (Used on 230V ac version)	380253	89536	380253	1		
C203, C204	Cap, Ta, 6.8uF ±20%, 35V	363713	56289	196D685X0035 KA1	2		
C204	Cap, Ta, 22uF ±10%, 15V	182816	56289	150D226X9015 B2	1		
C205	Cap, cer, 0.01uF +80/–20%, 500V	105668	56289	33C4186	1		
CR203, CR204	Diode, Hi-speed, switching	203323	07910	TD8253	2		
L201	Choke, 6 turn	320911	89536	320911	1		
Q201, Q202	Xstr, Si, NPN	330803	07263	MPS6560	2		
Q203	Xstr, Si, PNP	195974	04713	2N3906	1		
R201	Res, comp, 1M ±5%, ¼W	182204	01121	CB1055	1		
R202	Res, comp, 1.2K ±5%, ¼W	190371	01121	CB1225	1		
R204	Res, comp, 22 ±5%, ¼W	147884	01121	CB2205	1		
R205	Res, comp, 3K ±5%, ¼W	193508	01121	CB3025	1		
R206	Res, comp, 910 ±5%, ¼W	203851	01121	CB9115	1		
R207	Res, comp, 8.2K ±5%, ¼W	160796	01121	CB8225	1		
R208	Res, met film, 4.53K ±1%, 1/8W	260331	91637	MFF1-84R53	1		
R209	Res, met film, 16.9K ±1%, 1/8W	267146	91637	MFF1-816R9	1		
T2	Xfmr, inverter	372011	89536	372011	1		
U201	IC, voltage regulator, dual track	363861	49956	RC41950N	1		
1	Connector, plug/jack, red	170480	74790	105-752	1		
2	Receptacle, Amp Mod II	375329	00779	85863-3	5		

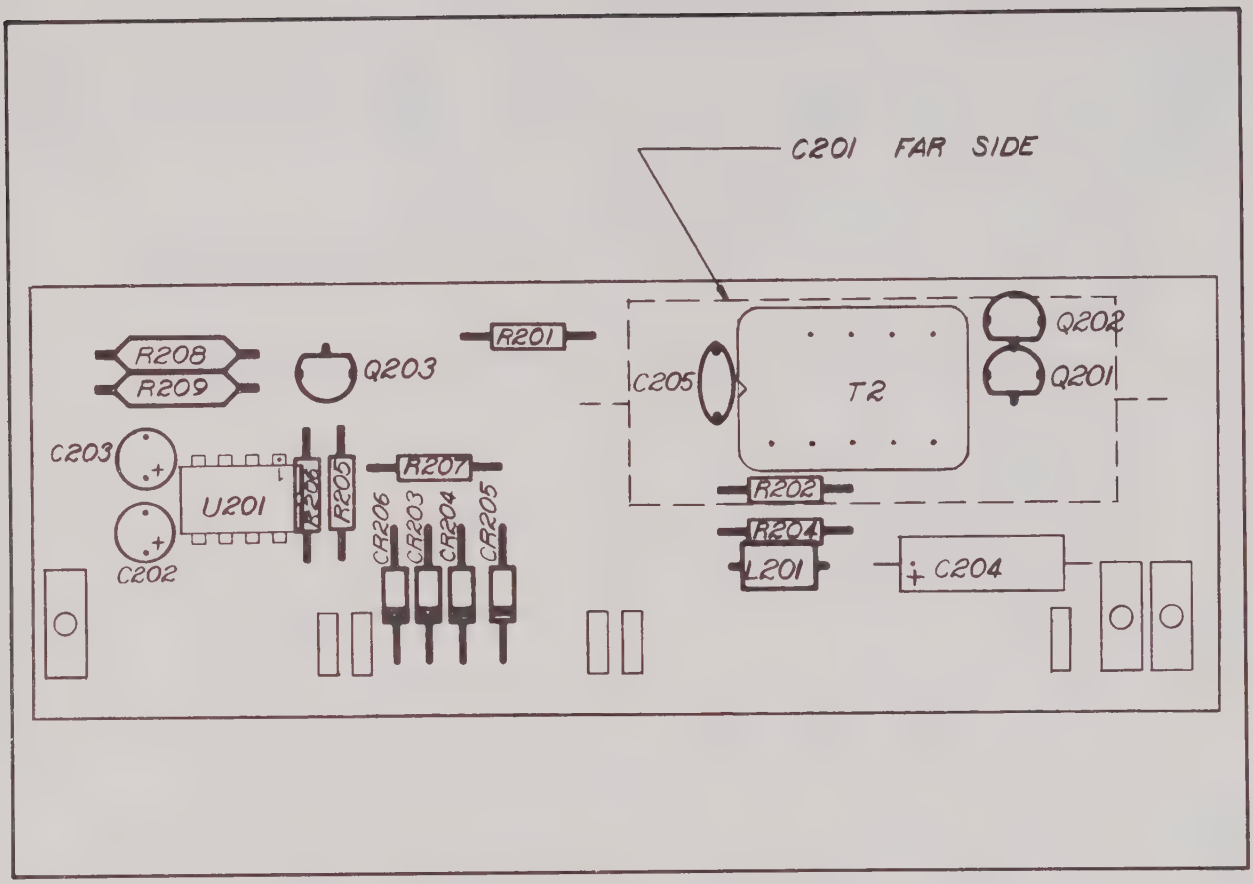

Figure 5-4. BATTERY POWER SUPPLY PCB ASSEMBLY (–01 Option)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	AC CONVERTER PCB ASSEMBLY	373852	89536	373852	REF		
	Figure 5-5						
C1	Cap, cer, 0.05uF GMV, 1KV/2KV	355420	71590	2DD65N5032	1		
C2,C19	Cap, var, 1.5 - 0.25pF, 2000VDC	218206	72982	530-000	2		
C5	Cap, cer, 15pF ±2%, 100V	369074	80031	2222-631-10159	1		
C6,C7, C32, C33, C34	Cap, cer, 0.025uF ±20%, 100V	168435	56289	C023B101H253 M	5		
C9	Cap, cer, 27pF ±2%, 100V	362749	80031	2222-631-10279	1		
C10	Cap, var, cer, 1.7 10 pF, 250V	375238	91293	9931	1		
C11	Cap, polystyrene, 9100pF	355321	91590	2DRP00J912GA A	1		
C12, C13	Cap, Ta, 330uF ±20%, 3V	385963	56289	196D337X0004 LA3	2		
C14, C20	Cap, mylar, 0.47uF ±10%, 100V	369124	73445	C280MAHA470 K	2		
C15	Cap, Ta, 39uF ±20%, 6V	163915	56289	196D396X0006 JA1	1		
C16	Cap, Ta, 4.7uF ±20%, 20V	161943	56289	196D475X0020	1		
C17	Cap, mica, 390pF ±1%, 500V	355339	71236	DM15F391F	1		
C18	Cap, cer, 2.2pF ±0.25pF, 100V	362731	80031	2222-631-09228	1		
CL1	Current limiter, regulator	334714	07910	TCR5315	1		
CR5, CR11, CR12, CR16, CR17	Diode, low cap	348177	03508	DA2429	1		
K6,K7, K8	Relay, reed, SPST	357566	71707	E8182	3		
Q1	Xstr, dual FET	379321	17856	E7024	1		
Q7,Q8	Xstr, Si, NPN	218396	04713	2N3904	2		
Q9	Xstr, Si, NPN	330803	07263	MPS6560	1		
R17	Res, met film, 2M ±0.5%, 1W	354894	80031	MF8C	1		

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R25	Res, deposited carbon, 10K ±5%, ¼W	348839	TOYO	R251-4035	1		
R26	Res, deposited carbon, 2.2K ±5%, ¼W	343400	TOYO	R251-42225	1		
R32, R33	Res, comp, 15K ±5%, ¼W	148114	01121	CB1535	2		
R37, R38, R45, R46, R47	Res, matched set, 5 pc	354902	91637	MFC	1		
R40	Res, comp, 240 ±5%, ¼W	221895	01121	CB2415	1		
R43, R75	Res, comp, 150K ±5%, ¼W	182212	01121	CB1545	2		
R49, R89	Res, met film, 68.1K ±1%, 1/8W	236828	91637	MFF1-868R1 PORM1PCT	2		
R50	Res, var, cermet, 20K ±10%, ½W	285122	71450	360S500A	1		
R51	Res, met film, 2.194K ±0.25%, 1/8W	375345	91637	MFF1-82R194 PORM1PCT	1		
R72	Re, var, cermet, 20K ±10%, ½W	291609	71450	360S203A	1		
R88	Res, met film, 59.0K ±1%, 1/8W	261677	91637	MFF1-859R04 PORM1PCT	1		
U2	IC, Operational Amplifier	329912	12040	LM318H	1		
	Connector, plug/jack, red	170480	74970	105-752	2		
	Shield	373829	89536	373829	1		
	Receptacle, Amp MOD II	375329	00779	85863-3	7		

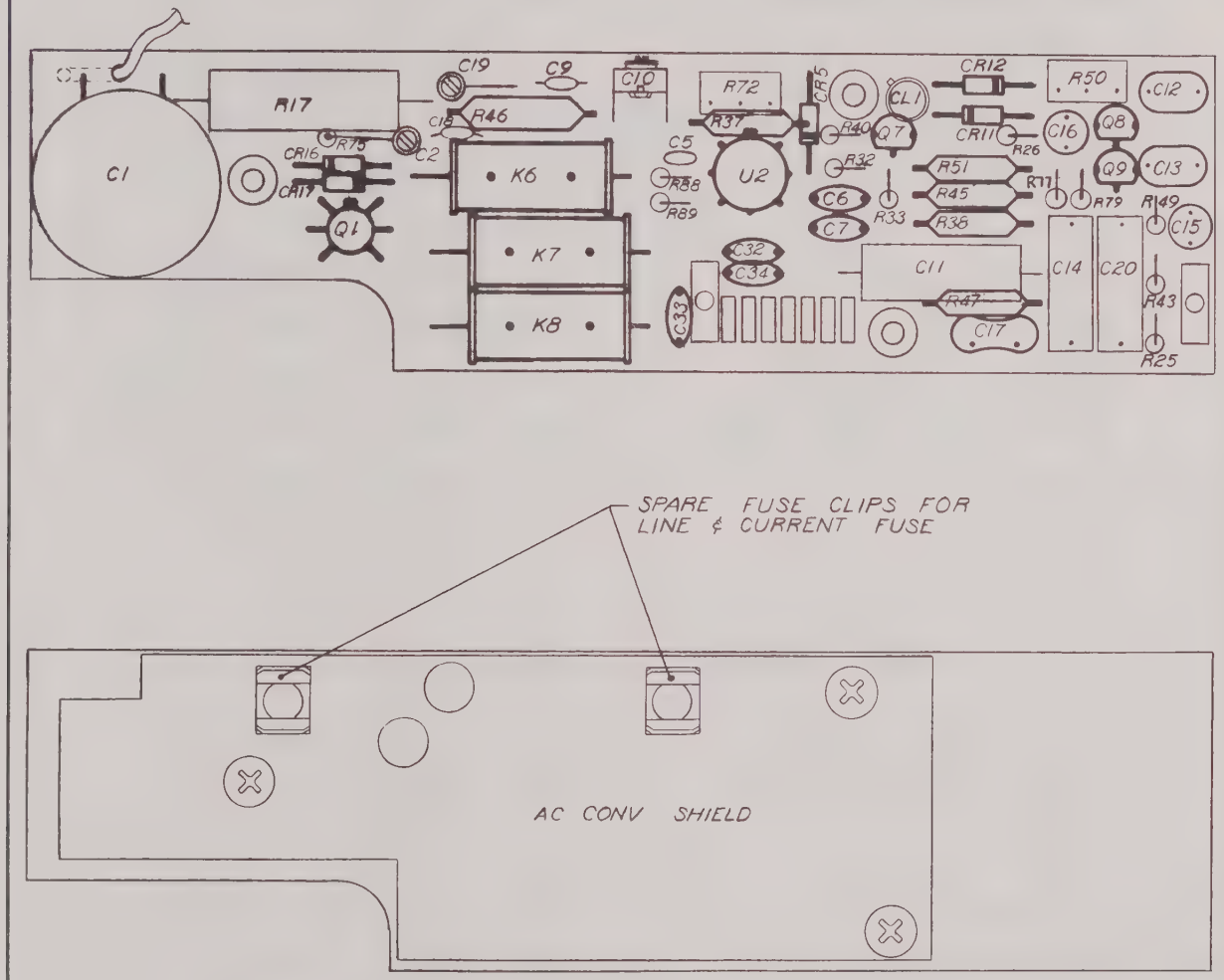

Figure 5-5. AC CONVERTER PCB ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	OHMS CONVERTER ASSEMBLY	373845	89536	373845	REF		
	Figure 5-6						
C3	Cap, mylar, 0.022uF ±20%, 250V	369165	25403	C281A/A22K	1		
C8	Cap, cer, 33pF ±2%, 100V	354852	80031	2222-638-10339	1		
CR2	Diode, zener	266601	07910	1N965B	1		
CR10	Diode, zener	357848	12954	1N4578	1		
CR22	Diode, Si, hi-speed, switch	203323	03508	DHD1105	1		
K5	Relay, reed, SPST	357582	71707	UF40070	1		
Q2,Q12	Xstr, Si, PNP	195974	04713	2N3906	2		
Q3	Xstr, FET, N-channel	357905	21845	F2690	1		
R19	Res, comp, 220 ±5%, ¼W	147959	01121	CB2215	1		
R21	Res, var, cermet, 200 ±10%, ½W	285148	71450	360S201A	1		
R22	Res, met film, 2K ±1%, 1/8W	335422	91637	MFF1-8	1		
R27	Res, var, cermet, 100 ±10%, ½W	285130	71450	360S101A	1		
R28	Res, WW, power, 9.95K ±0.1%, 5W	363275	ARC 1DY	160-9950-1	1		
R29	Res, var, cermet, 50 ±10%, ½W	285122	71450	360S500A	1		
R35	Res, WW bobbin, 13.5K ±0.1%, 0.15W	363119	54294	SP21	1		
R41	Res, selected				1		
R42, R99	Res, comp, 10K ±5%, ¼W	148106	01121	CB1035	2		
R48	Res, comp, 2.2K ±5%, ¼W	148049	01121	CB2225	1		
R90	Res, selected				1		
R91	Res, met film, 4.22K ±1%, 1/8W	168245	91637	MFF1-8	1		
U1	IC, operational amplifier	357830	12040	LH0042C	1		
U3	IC, linear, operational amplifier	363515	24355	AD301AN	1		
	Connector, plug/jack, red	170480	74970	105-752	2		
	Receptacle, Amp, MODII	375329	00779	8586303	8		
	Socket, IC, 14-pin DIP	276527	23880	TSA2900-14W	1		

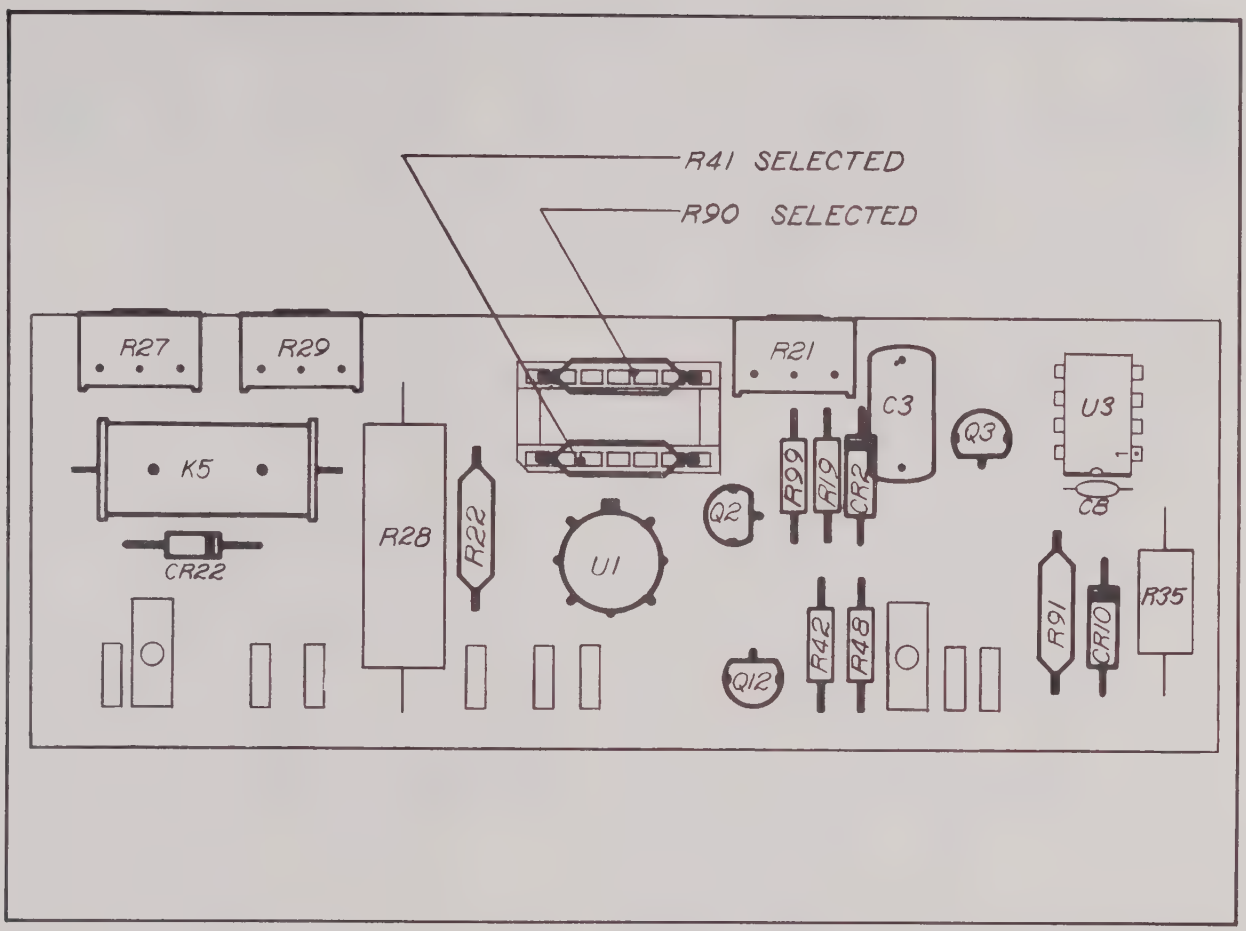

Figure 5-6. OHMS CONVERTER ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	INPUT DIVIDER PCB ASSEMBLY	365890	89536	365890	REF		
	Figure 5-7						
CR13, CR18, CR19	Diode, Si, 150 mA	203323	03508	DHD1105	3		
K2, K3	Relay, dry reed, SPST	357582	71707	UF40070	2		
K4	Coil, reed relay	269019	71707	U6P	1		
R4	Res, var, cermet, 5K ±10%, ½W	288282	71450	360S502A	1		
R6	Re, var, cermet, 500 ±10%, ½W	291120	71450	360S501A	1		
R8	Res, var, cermet, 50 ±10%, ½W	285122	71450	360S500A	1		
RN3	Res, network, 5 pc	375105	01281	JF002	1		
	Connector, plug/jack, red	170480	74970	105-752	2		
	Receptacle, Amp, MODII	375329	00779	85836-3			

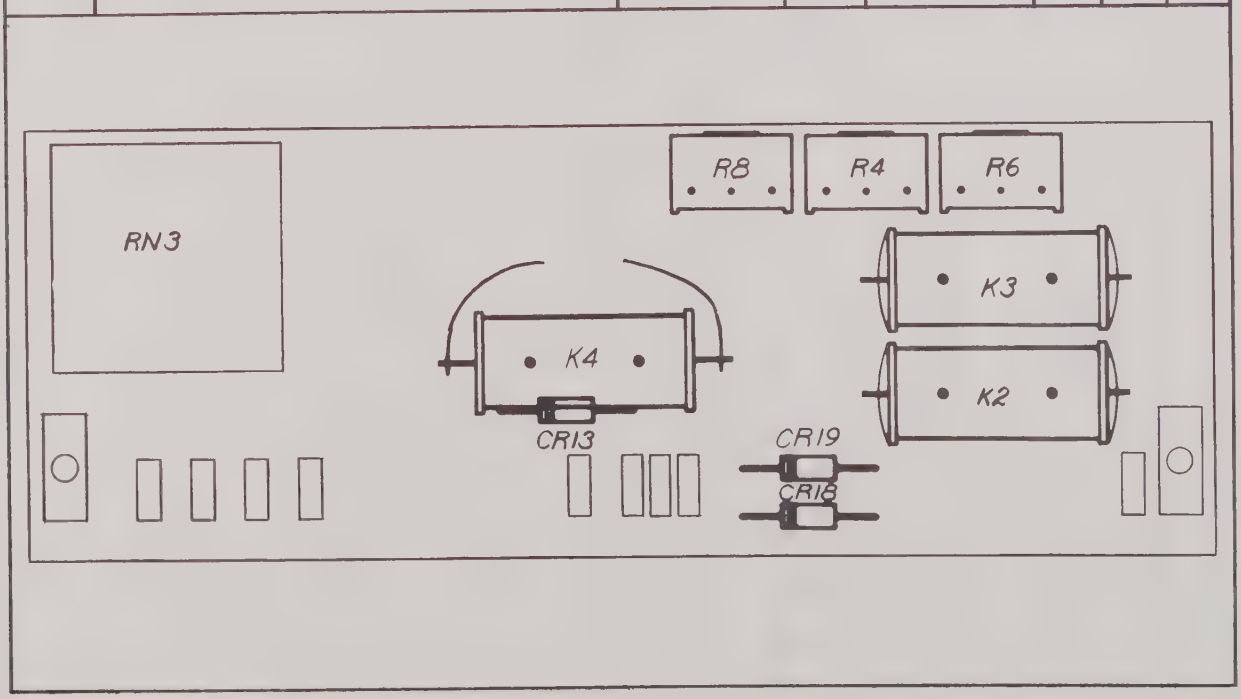

Figure 5-7. INPUT DIVIDER PCB ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	DOU PCB ASSEMBLY –02 Option	366351	89536	366351	1		
	Figure 5-8						
C1, C3	Cap, elect, 200uF +50/–10%, 10V	236935	73445	ET221X010A5	2		
C2	Cap, plstc, 0.022uF ±10%, 50V	271577	06001	75F1R5A222	1		
C4	Cap, cer, 0.05uF +80/–10%, 25V	148924	32897	5855Y5U503Z	1		
CR1	Rectifier, bridge	296509	51605	FB100	1		
CR2	Diode, zener, 5.6V	277236	07910	1N752A	1		
Q1, Q2, Q5	Xstr, Si, NPN	218396	04713	2N3904	3		
Q3,Q4	Xstr, Si, PNP	195974	04713	2N3906	2		
R15, R16	Res, desposited carbon, 1K ±5%, ¼W	343426	TOYO	R251025	2		
R17, R18	Res, comp, 4.7M ±5%, ¼W	220046	01121	CB4755	2		
RN1	Res, network	385930	89536	385930	1		
T1	Xfrm, power	374652	89536	374652	1		
U1 thru U4, U10	IC, COMOS, dual 4-bit static shift register	340125	04713	MC14015CP	5		
U5	IC, C-MOS, dual, type D flip-flop	340117	04713	MC14013CL	1		
U6	IC, C-MOS, NOR Gate	355172	04713	MC14001CL	1		
U7,U8, U12, U13, U14	IC, C-MOS, hex, buffer/inverter	381848	49671	CD4049AE	5		
U9	IC, DTL, C-MOS, quad, bilateral SW	363838	49671	CD4016AE	1		
U11	IC, C-MOS, dual 4-input NOR gate	363820	49671	CD4002AE	1		
U16, U17	Opto-Isolator, photo Xstr	380014	89536	MCT2	2		
	Cable, flat	385922	08261	5112-007.25X	1		
	Socket, IC, 14 pin	276527	23880	TSA2900-14W	4		
	Socket, IC 16 pin	276535	23880	TSA2900-16W	11		

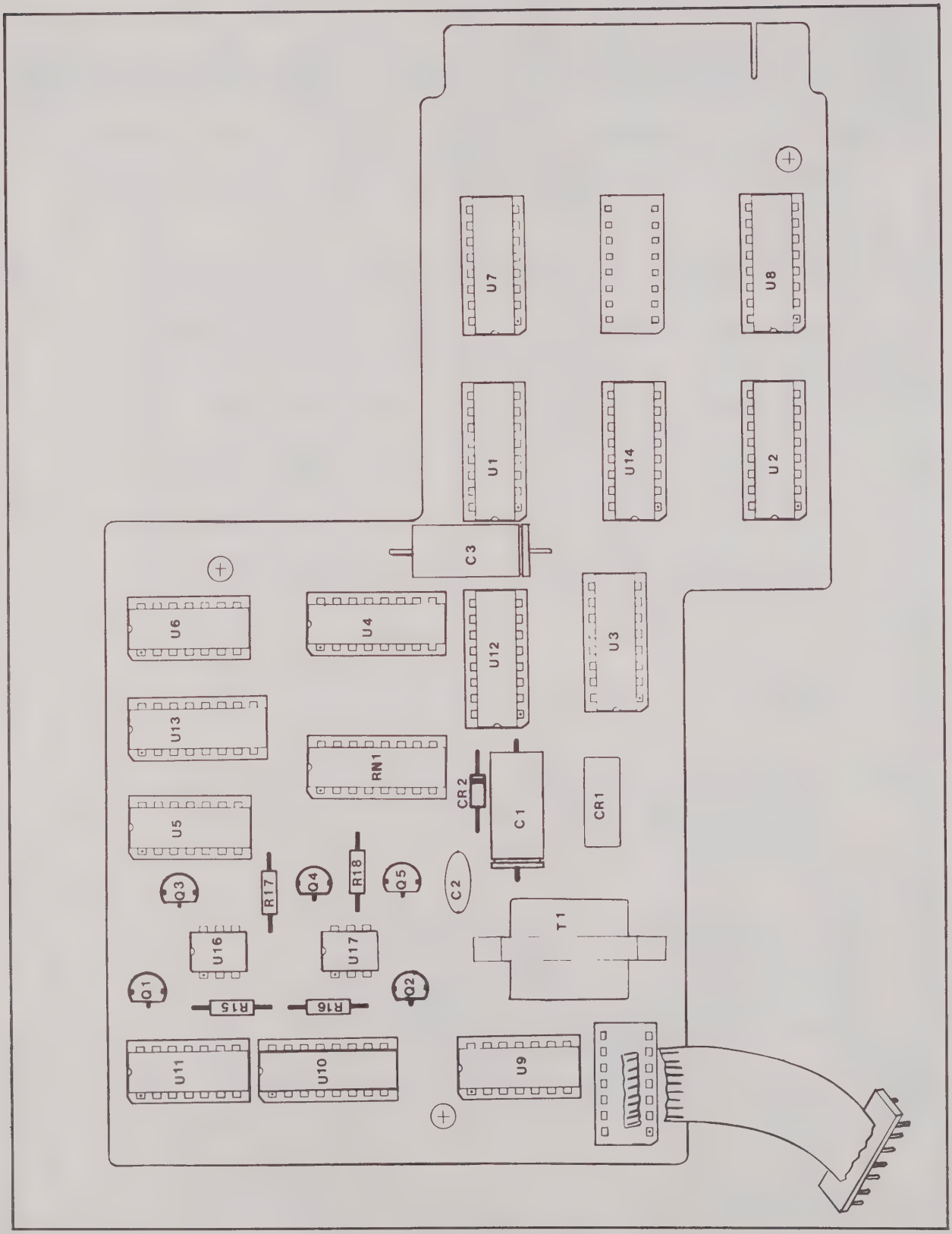

Figure 5-8. DOU PCB ASSEMBLY –02 Option

Section 6

Option & Accessory Information

6-1. INTRODUCTION

6-2. This section of the manual contains information pertaining to the options and accessories available for your instrument. Each of the options and accessories are described under separate major headings containing the model or option number. The option descriptions contain applicable operating and maintenance instruction, and field installation procedures. Replaceable parts and schematics for all options are given in Sections 5 and 7, respectively.

6-3. CARRYING CASE (C80)

6-4. The Model C80 Carrying Case, Figure 6-1, is a soft vinyl plastic container, designed for the storage and transport of the 8600A. The case provides the 8600A with adequate protection against normal handling and storage conditions. A separate storage compartment is provided for test leads, power cord, and other compact accessories.

6-5. CARRYING CASE (C86)

6-6. The Model C86 Carrying Case, Figure 6-2, is a molded polyethylene container, with handle, designed for use in transporting the 8600A. This rugged case provides the 8600A with maximum protection against rough handling and adverse weather conditions. A separate storage compartment is provided for test leads, power cord, and other compact accessories.

6-7. FRONT PANEL DUST COVER (M00-100-714)

6-8. The front panel dust cover is a molded plastic snap-on accessory which fits over the front panel of the 8600A. The dust cover provides protection for the front panel controls, and is useful when storing or transporting the 8600A.

6-9. RACK MOUNTING KITS

6-10. Introduction

6-11. Three rack mounting kits are available for mounting the 8600A in a standard 19-inch equipment rack. The kits, listed in Table 6-1, provide the option of either offset mounting (left/right), center mounting or side-by-side mounting.

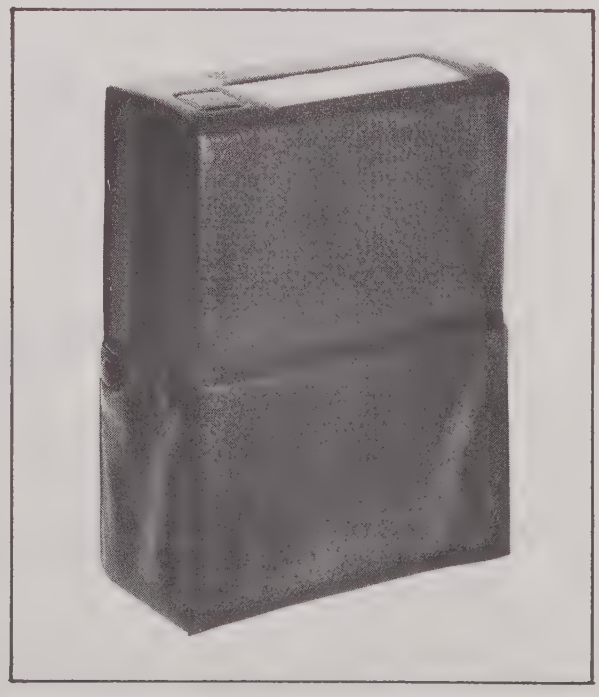

Figure 6-1. MODEL C80 CARRYING CASE

Figure 6-2. MODEL C86 CARRYING CASE

6-12. Installation Procedure

6-13. Installation instructions for each of the rack mounting kits is given in the following paragraphs. Use the procedure which corresponds to the model number of the kit being installed.

6-14. OFFSET AND CENTER MOUNTING KITS (M00-200-611 and M00-200-612)

a. Remove 8600A carrying handle by removing the handle disc decals and the handle mounting screws.

b. Remove screw from rear of case and separate the case from the 8600A.

c. Install the side mounting brackets, as shown in Figure 6-3, and secure them to the mounting panel using the nuts provided.

d. Insert the front of the 8600A case through the opening on the back side of the mounting panel.

e. Install the handle mounting screws through the side brackets into the handle mounting bosses. Don't over tighten these screws.

f. Slide the 8600A through the mounting panel and into the case. Install and tighten the retaining screw at the rear of the case.

6-15. SIDE–BY–SIDE MOUNTING KIT (M00-200-613)

a. Remove the carrying handles from both 8600A's by removing the handle disc decals and the handle mounting screws.

b. Remove the retaining screw from the rear of the cases and separate the instruments from their cases.

c. Install the center mounting bracket, as shown in Figure 6-4, and secure it to the mounting panel using the nuts provided.

d. Install the clamp screw in the center mounting bracket using the nuts and washers provided.

e. Insert the front of the 8600A cases through the openings on the back side of the mounting panel. Make sure the case's handle mounting bosses are inserted into the clamp hole of the center mounting bracket

f. Tighten the clamp screw.

g. Install the side mounting brackets and secure them to the front panel using the nuts provided.

h. Install the handle mounting screws through the side brackets into the handle mounting bosses. Don't over tighten these screws.

Slide the 8600A's through the mounting panel and into their cases. Install and tighten the retaining screw at the rear of both cases.

Table 6-1. RACK MOUNTING KITS

MOUNTING STYLE	MODEL NUMBER
Offset	M00-200-611
Center	M00-200-612
Side-By-Side	M00-200-613

6-16. DELUXE TEST LEAD KIT (A80)

6-17. The deluxe test lead kit, shown in Figure 6-5, contains two test leads with probes (red and black), and five pairs of universal probe tips. The probe tips include: alligator clips, test prod tips, pin tips, banana plug tips, and binding post lugs. A convenient plastic pouch is provided for storing the contents of the test lead kit.

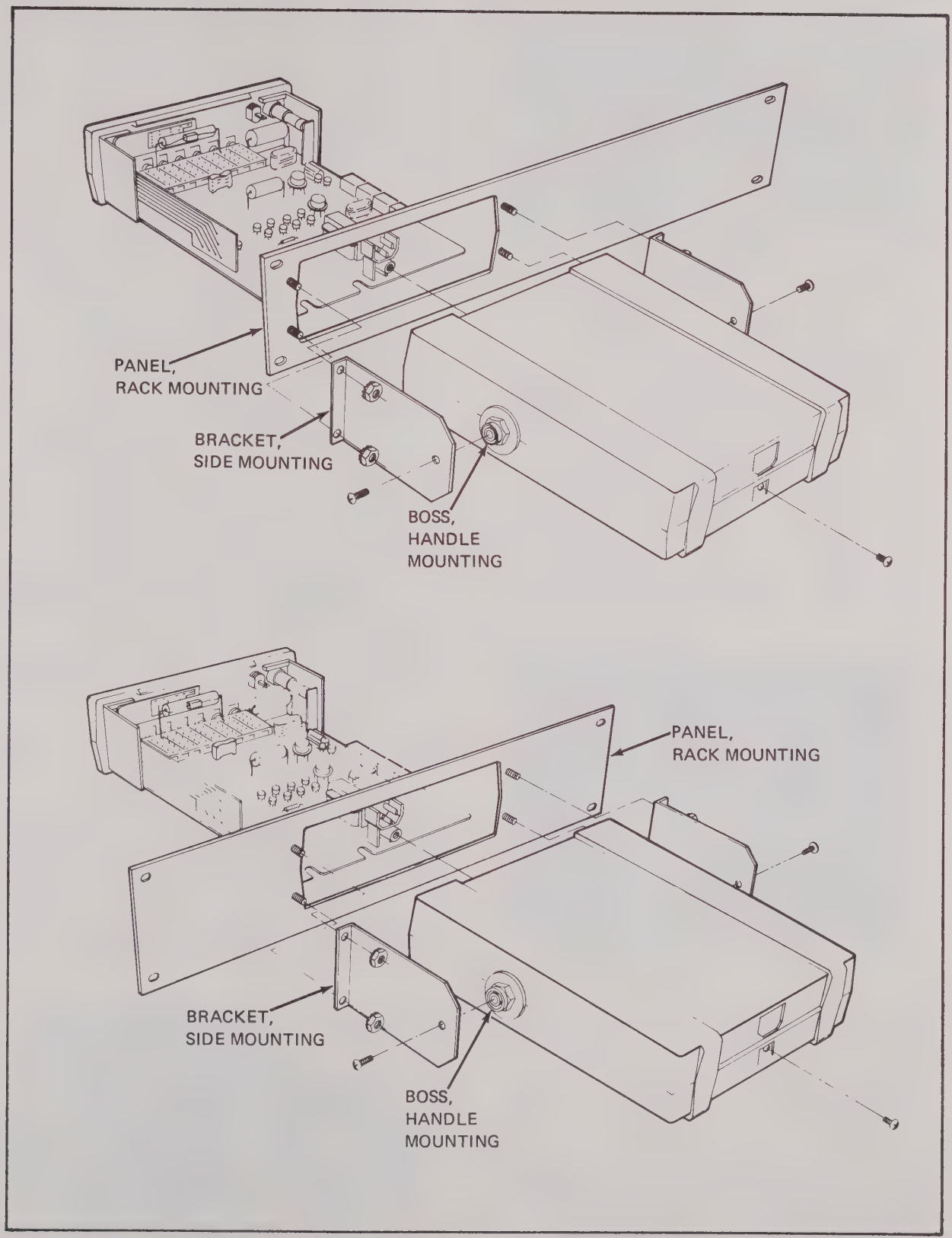

Figure 6-3. RACK MOUNTING KITS, OFFSET AND CENTER MOUNTING

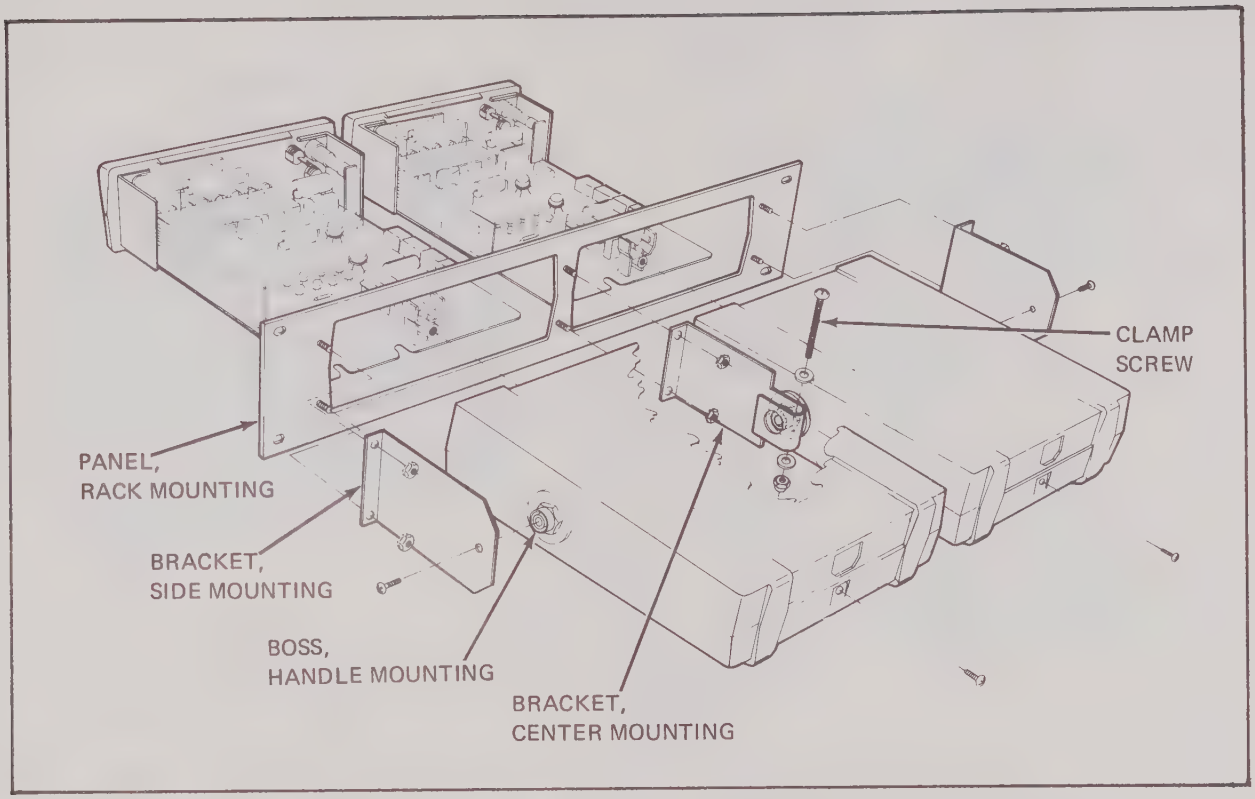

Figure 6-4. RACK MOUNTING KIT, SIDE-BY-SIDE MOUNTING

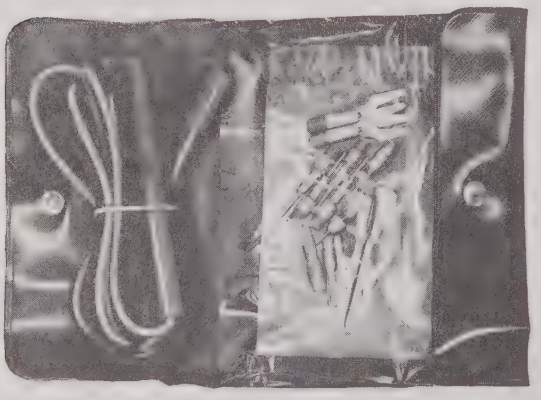

Figure 6-5. DELUXE TEST LEAD KIT (A80)

6-18. CURRENT PROBE, CLAMP-ON (80I-600)

6-19. Introduction

6-20. The Model 80I-600, as shown in Figure 6-6, is a clamp-on current probe which is used to extend the current measurement capabilities of the 8600A. The probe is designed to measure currents of 2 to 600 amperes at frequencies of up to 400 Hz with ±3% accuracy. The clamp-on feature allows current to be measured without breaking the circuit under test.

6-21. Operation

6-22. Use the following procedure for operating the 8600A with the 80I-600 probe:

a. Plug the 80I-600 dual-banana plug into the MA and COMMON INPUT terminals on the 8600A.

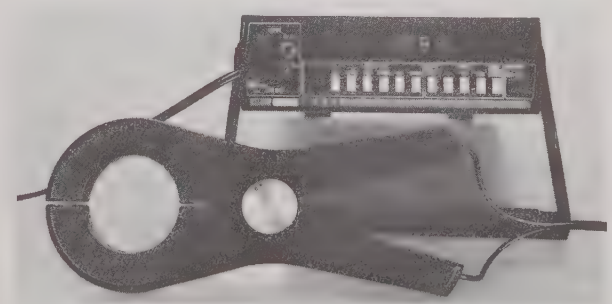

Figure 6-6. AC CURRENT PROBE, CLAMP-ON (80I-600)

b. Depress the AC MA pushbutton (FUNCTION)

c. Select the desired current range in accordance with Table 6-2.

d. Clamp probe around current carrying conductor to be measure.

e. Observe ac current reading in amperes on the 8600A readout.

NOTE

Clamping the probe around more than one current carrying conductor at a time produces a reading that is the vector sum of the currents in the conductors.

Table 6-2. 8600A RANGES FOR CURRENT PROBE (801-600)

RANGE SELECTED	CURRENT RANGE WITH 801-600 PROBE
2000 MA	200A to 600A
200	20A to 200A
20	2A to 20A

6-23. HIGH VOLTAGE PROBE (80K40)

6-24. Introduction

6-25. The Model 80K-40 High Voltage Probe as shown in Figure 6-7, provides the 1000X attenuation necessary to extend the dc voltage measuring capabilities of the 8600A up to 40 kV dc. A schematic of the 80K-40 probe is shown in Figure 6-8.

6-26. Specifications

Overall Accuracy:	20kV to 30kV ±2% (Calibrated 1% at 25kV)
Upper Limit:	Changes linear from 2% at 30kV to 4% at 40kV
Lower Limit:	Changes linear from 2% at 20kV to 4% at 1kV
Voltage Range:	1kV to 40kV
Input Resistance:	1000MΩ
Division Ratio:	1000:1

Figure 6-7. HIGH VOLTAGE PROBE (80K-40)

6-27. Operation

6-28. Use the following procedure for operating the 8600A with the 80K-40 probe:

a. Plug the 80K-40 dual-banana plug into the V-Ω and LO INPUT terminals on the 8600A.

b. Depress the DCV pushbutton (FUNCTION)

c. Select the desired voltage range in accordance with Table 6-3.

d. Connect the common probe lead to a suitable ground and touch the probe tip to the circuit point to be measured.

e. Observe dc voltage reading displayed in kilovolts on the 8600A readout.

CAUTION

Before touching probe tip to a high voltage source, always connected probe common lead to circuit common. Removal of the probe common connection during a measurement may result in damage to the 8600A.

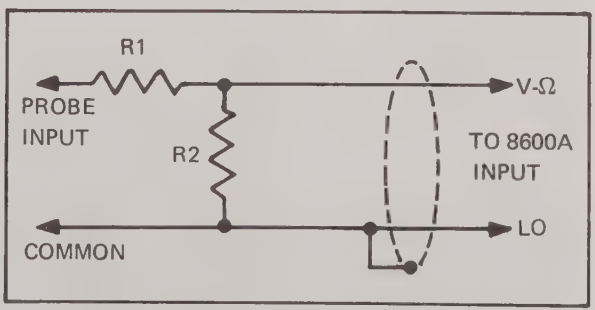

Figure 6-8. HIGH VOLTAGE PROBE, SCHEMATIC

Table 6-3. 8600A RANGES FOR DC HV PROBE (80K-40)

RANGE SELECTED	VOLTAGE RANGE WITH 80K-40 PROBE
200	20 to 40 kV
20	2 to 20 kV
2	1 to 2 kV

6-29. HIGH FREQUENCY PROBE (80RF-1)

6-30. Introduction

6-31. The Model 80RF-1 High Frequency Probe, Figure 6-9, extends the frequency range of the 8600A to include 100 kHz to 500 MHz for ac voltage measurements from 0.25 to 30V rms. The 80RF-1 operates in conjunction with the dc voltage ranges, and is connected to the 8600A using a shielded dual-banana plug and an adapter.

6-32. Specifications

Voltage: 0.25V to 30V

Response: Responds to peak value of input. Calibrated to read rms value of a sine wave input.

AC to DC Transfer Accuracy: Loaded with 10 megohms ±10%.

	100 kHz–100 MHz	100 MHz–500 MHz
+10°C to +30°C	+5%	+7%
–10°C to +40°C	+7%	+15%

< ±3 db at 10 kHz and 700 MHz

Input Impedance: 4 megohms shunted by 2 ±0.5 pf

Maximum Input: 30 volts rms ac, 200 volts dc

Cable Connections: Shielded dual banana plug fits all standard ¾-inch dual banana connectors.

Cable Length: 4 ft.(121,9 cm) minimum

Weight: 3½ oz. net

Accessories: Ground lead, straight tip, hook tip, high frequency adapter

6-33. Operating Notes

6-34. The straight and the hooked tips supplied with the probe are useful for making voltage measurements up to 100 MHz. For measurements above 100 MHz use the high frequency adapter tip with mating connector and 50 ohm terminations.

6-35. The maximum input to the probe is 30V rms or 200V dc. These voltage limits may be used in combination so that the ac component of an ac signal superimposed on dc level can be measured.

CAUTION

Changing the dc level of the input signal by more than 200 volts will damage the probe.

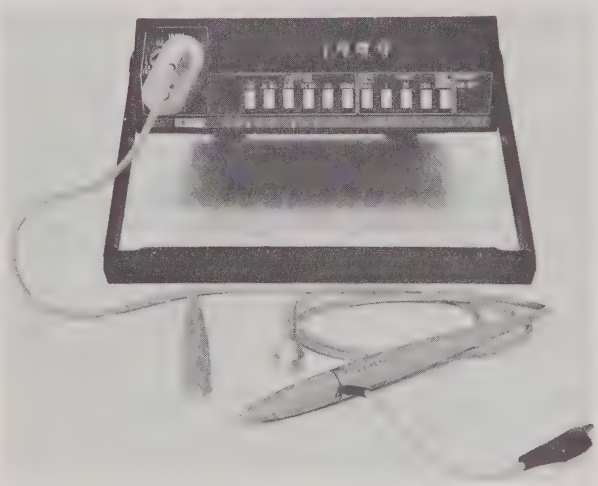

Figure 6-9. 80RF–1, HIGH FREQUENCY PROBE

6-36. Operation

6-37. Use the following procedure for operating the 8600A with the 80RF-1 probe:

a. Connect the 80RF-1 shielded dual-banana plug to the 8600A V-Ω and LO INPUT terminals.

b. Attach the desired probe tip to the probe body.

c. Depress the DCV pushbutton (FUNCTION)

d. Select the 20, 200, or 1200V range.

NOTE

The probe loading error caused by the 1000MΩ input impedance on the 8600A 200 mV and 2V ranges can be corrected by placing a 10MΩ ±5% resistor across the dual-banana plug terminals.

e. Connect the probe's ground lead to a suitable ground when using the straight or hooked probe tip. The ground clip is not required when using the high frequency adapter with an appropriate 50 ohm termination.

f. Touch the probe tip to the circuit point to be measured.

g. Observe the voltage reading displayed in volts rms on the 8600A readoug.

6-38. Theory of Operation

6-39. A schematic diagram of the 80RF-1 High Frequency probe is given in Figure 6-10. Capacitor C1 is used as a dc blocking capacitor, diode CR1 is used as a detector, and resistors R1, R2, R3 and R_{in} form a divider network. During the negative half cycle of the ac input voltage, C1 charges through CR1 to the negative peak value of the input signal. This negative charge path provides the zero reference for the dc output signal. During the positive half cycle of the input signal the charge on C1 is added to the peak value of the positive input to produce a positive peak-peak voltage at the junction of C1 and CR1. The divider network scales this voltage to provide a dc output voltage which is equal to the rms value of the input signal.

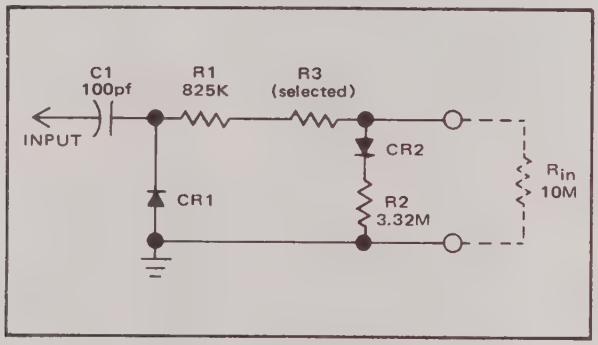

Figure 6-10. 80RF–1 SCHEMATIC

6-40. Diode CR2 compensates for the non-linearity of the detector, and R3 is a selected part having a value of 50 kΩ to 100 kΩ.

6-41. Maintenance

6-42. PERFORMANCE TEST

6-43. The low and high frequency tests given below are used to verify the ac-to-dc transfer accuracy of the 80RF-1 High Frequency Probe.

6-44. Low Frequency Response

6-45. Connect equipment as shown in Figure 6-11, and perform the following steps.

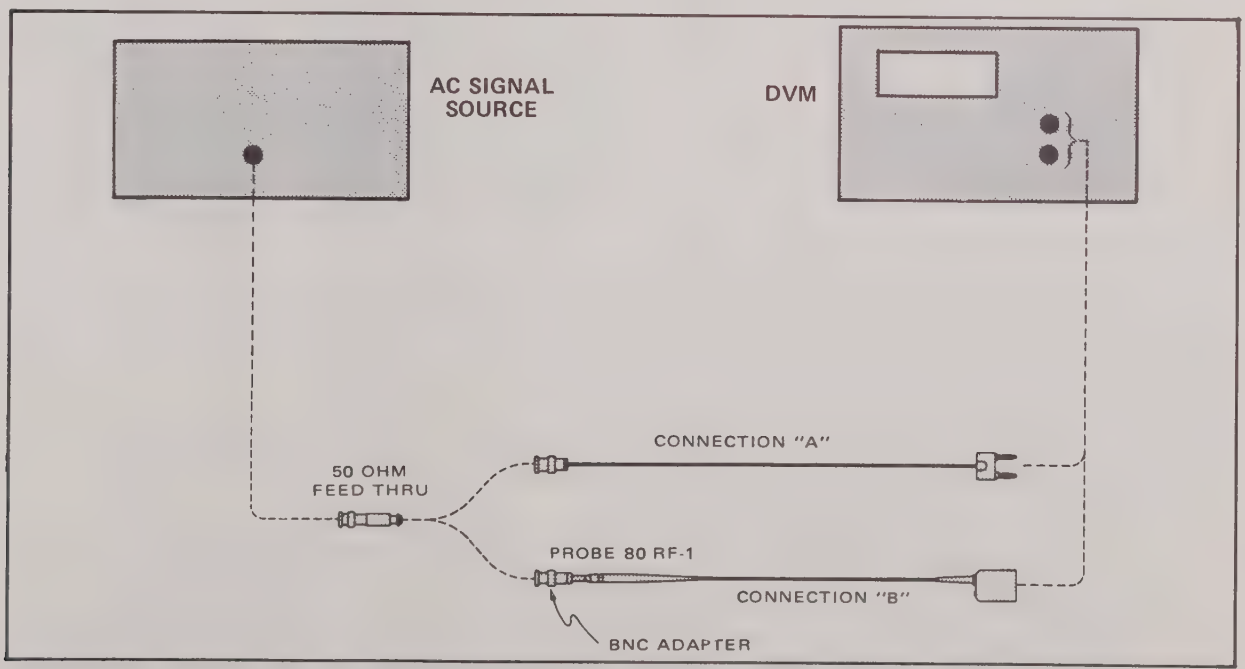

Figure 6-11. LOW FREQUENCY RESPONSE CHECK

a. With equipment as shown in connection "A" adjust the ac signal source for an output of 3.000V rms at 100 kHz as measured on the DVM.

b. In connection "B" with the DVM set to measure V dc, observe a probe output of 3.15 to 2.85V dc.

c. Placing cables back in connection "A", decrease the ac signal source by 10 db (0.95V rms).

d. Moving back to connection "B", observe a voltmeter indication of between 1.00 and 0.90V dc (10 db down from 3.0V dc).

e. In connection "A", decrease the ac signal source an additional 10 db (to 0.3V rms) as indicated by the voltmeter in its ac function.

f. Back to "B", observe a voltmeter reading of .315 to .285V dc.

g. Return the ac signal source back to 3.000V rms.

h. Repeat steps a through g with frequencies of 500 kHz, 1 MHz, and 10 MHz.

6-46. High Frequency Response

6-47. Connect equipment to the 80RF–1 probe as shown in Figure 6-12, and perform the following steps:

a. Set the ac signal source to 100 MHz with an output level of 10 milliwatts as indicated on the power meter. Ensure that the ac signal source has stabilized at the 10 milliwatt output.

b. Observe that the voltmeter indication is between 0.757 and 0.657V dc, (0.707V dc corresponds to 10 milliwatts into 50 ohms.)

c. Repeat the above for frequencies of 200 MHz, 300 MHz, 400 MHz, and 480 MHz.

6-48. CALIBRATION

6-49. Should the 80RF–1 require recalibration, perform the following steps:

a. Perform steps a and b in paragraph 6-44, with a frequency of 1 MHz.

b. Observe the dc voltmeter; a reading below 3V dc calls for a decrease in the value of R3, a reading above 3V dc calls for an increase in R3. Resistor R3 should be a 1/8W metal film type. In a probe that is working properly, a 30 kΩ change in R3 will produce about a 1% deviation in the reading.

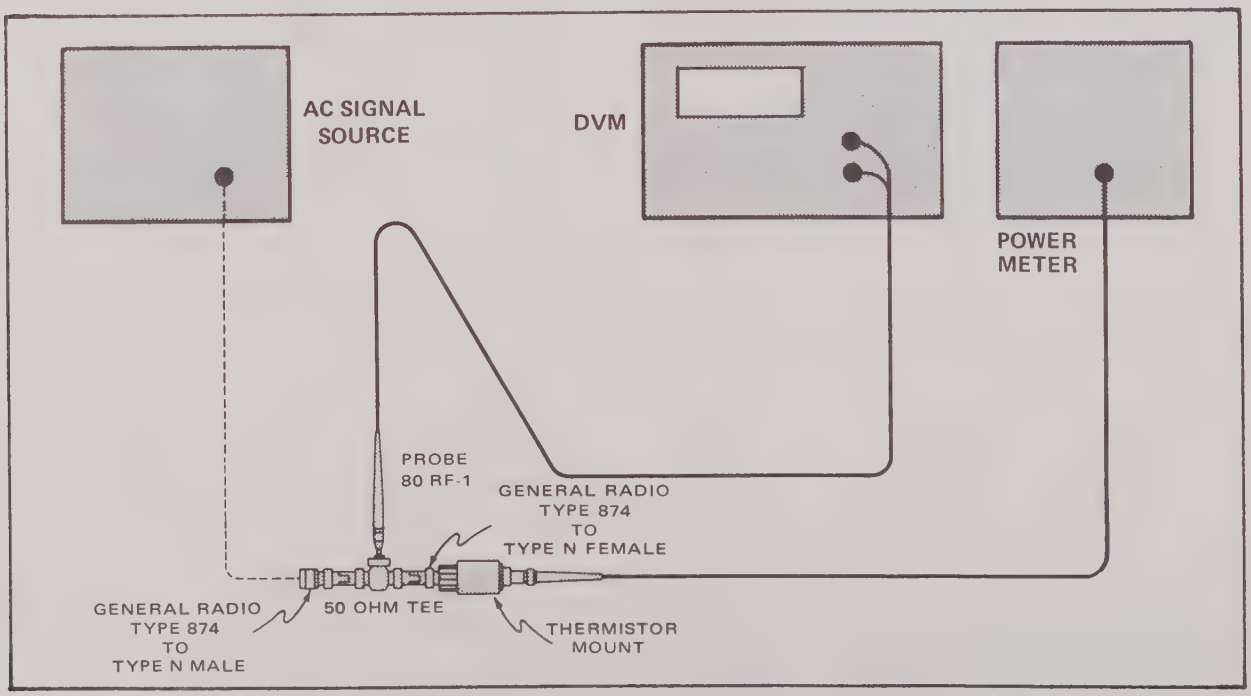

Figure 6-12. HIGH FREQUENCY RESPONSE CHECK

6-50. HIGH FREQUENCY PROBE (81RF)

6-51. Introduction

6-52. The Model 81RF High Frequency Probe, Figure 6-13, extends the frequency range of the 8600A to include 100 kHz to 100 MHz for ac voltage measurements from 0.25 to 30V rms. The 81RF operates in conjunction with the dc voltage range, and is connected to the 8600A using a shielded dual-banana plug and an adapter.

6-53. Specifications

Transfer Accuracy:	±1 dB from 100 kHz to 100 MHz
Voltage Range:	.25V rms to 30V rms (operated into a 10 MΩ input resistance voltmeter). Peak responding calibrated to read rms value of a sinewave.
Maximum DC Input:	350V
Input Impedance:	12MΩ shunted by ≈ 15 pf maximum

6-54. Operation

6-55. Use the following procedure for operating the 8600A with the 81RF probe:

a. Connect the 81RF shielded dual-banana plug to the 8600A V-Ω and LO INPUT terminals.

b. Attach the desired probe tip to the probe body.

c. Depress the DCV pushbutton (FUNCTION)

d. Select the desired voltage range.

e. Connect the probe's ground lead to a suitable ground.

f. Touch the probe tip to the circuit point to be measured.

g. Observe the voltage reading displayed in volts rms on the 8600A readout.

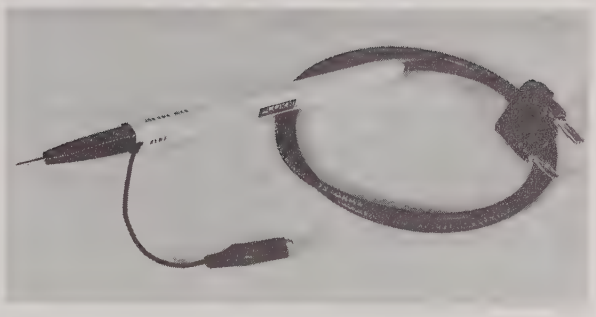

Figure 6-13. HIGH FREQUENCY PROBE (81RF)

6-56. BATTERY PACK, OPTION –01

6-57. Introduction

6-58. The Battery Pack provides the 8600A with the capability of operating as a portable (battery-operated) instrument. Four nickle cadmium (Ni-cad) batteries allow, typically 8 hours of portable operation before recharging is necessary. The batteries are recharged by connecting the 8600A to the ac power line. If desired, the 8600A can be operated during the charging process, however, the charging time will be increased.

6-59. Specification

6-60. The specifications for the Battery Pack are given in Section 1 of this manual.

6-61. Operation

CAUTION!

Damage may result if alkaline, zinc-carbon, or mercury batteries are charged in the 8600A.

6-62. With a fully charged battery pack, the 8600A can be disconnected from line power and operated for typically 8 hours, as a portable instrument. When the display digits are too dim to read, the battery pack should be recharged by switching the POWER switch to OFF and connecting the instrument to the ac power line. The total charge time is approximately 16 hours. If desired, the 8600A can be operated during the charging process, however, the charge time will be extended to approximately 43 hours.

NOTE

Battery manufacturers recommend that Ni-cad batteries be recharged at least every 90 days. Storage temperatures below +25°C are recommended.

6-63. Theory of Operation

6-64. The 8600A equipped with the battery pack option (–01) uses the power transformer configuration shown in Figure 7-2 and the battery power supply pcb shown in Figure 7-6. With the POWER switch in the ON position, the batteries are connected to the input of the battery power supply pcb, a dc-to-dc converter.

6-65. The +5 volts from the battery is applied to the primary windings of T201, causing transistors Q201 and Q202 to alternately conduct. The alternating current in the primary windings is stepped up by the secondary winding and applied to a bridge rectifier consisting of CR203 through CR206. The two halves of the rectifier output are applied to a dual track voltage regulator U201. The resulting +15V and –15V power supply voltages provide the operating power for the instrument.

6-66. Maintenance

6-67. BATTERY REPLACEMENT

6-68. Use the following procedure for removing and replacing batteries:

CAUTION!

Do not attempt to charge alkaline, zinc-carbon or mercury batteries in the 8000A.

a. Disconnect line cord. Remove retaining screw at rear of instrument case, and remove instrument from case.

b. On the underside of the pcb, remove the two threaded bolts securing the battery holders.

c. Remove the holder tops and batteries.

d. Replace the batteries with 1.2 volt nickel-cadmium batteries (JF Part No. 346924). Install the batteries in the direction indicated by the polarity markings on the battery holder.

6-69. FUSE REPLACEMENT

6-70. The input power fuse F1 is located on the interior of the instrument near the power transformer. If replacement is necessary, use an MDL 1/8A (slo-blo) for battery powered instruments.

CAUTION!

Line potential exists on the fuseholder whenever the instrument is plugged into the line.

6-71. DATA OUTPUT UNIT (OPTION –02)

6-72. Introduction

6-73. The Data Output Unit (DOU) provides digital measurement information to a rear panel output connector for use by remote display instruments or data printers. The output data is in parallel bcd format and is compatible with the Fluke Model 2010A Digital Printer.

6-74. Specifications

6-75. The specifications for the DOU are presented in Section 1 of this manual.

6-76. Operation

6-77. DOU DATA IDENTIFICATION

6-78. The data available at the rear panel DOU connector is listed in Table 6-4. The connector pin assignment and logic level requirement for each signal is provided.

6-79. DATA UPDATE

6-80. The DOU output can be updated by an external command (ARM ENABLE, ARM INPUT) or allowed to update automatically (FREE RUN) at the end of each new 8600A measurement. A logic level 1 (+4.75 to +5.25V) applied to DOU connector pin D will cause the data on the connector to be updated 2.5 times each second. The data can be updated by an external command by applying a logic 0 (0.0 to +0.4V) to pin D, a logic 1 to pin B (ARM ENABLE) and a positive trigger pulse to pin C (ARM INPUT) each time the data is to be updated.

6-81. BUSY FLAG

6-82. The updating period of the DOU is signified by the BUSY (pin 2) and BUSY (pin 4) outputs from the DOU. During this period the data on the output connector pins will be changing to reflect the updated input. Either the positive true BUSY or negative true BUSY flag can be used to inhibit the data recording instrument during this time period.

6-83. POLARITY FLAG

6-84. The polarity of the dc voltage input to the A-D Converter determines which polarity sign will be presented at DOU output pin 3; pin 5 provides POL in Model 8800A only. A positive dc level at the converter will cause DOU output pin 3 to go to logic 1 and pin 5 (8800A) to go to logic 0. A negative converter input will cause the opposite logic level output from each pin.

Table 6-4. DOU DATA IDENTIFICATION

DOU DATA NAME	DOU PIN NO.		DOU DATA NAME
+5V	1	A	LOGIC RETURN
BUSY FLAG	2	B	ARM ENABLE
POL FLAG	3	C	ARM INPUT
BUSY FLAG	4	D	FREE RUN
(8800A) POL FLAG	5	E	NOT USED
OVERLOAD Ω	6	F	c RANGE CODE
RANGE CODE b	7	H	a RANGE CODE
W6	8	J	X6 4 BITS
Y6	9	K	Z6 LSD (8800A)
W5	10	L	X5 4 BITS
Y5	11	M	Z5 LSD (8600A)
W4	12	N	X4 4 BITS
Y4	13	P	Z4 4SD
W3	14	R	X3 4 BITS
Y3	15	S	Z3 3SD
W2	16	T	X2 4 BITS
Y2	17	U	Z2 2SD
(GND) W1	18	V	X1 (GND 4 BITS MSD
(GND) Y1	19	W	Z1 ONE ACTIVE
	20	X	NOT USED
	21	Y	NOT USED
NOT USED	22	Z	NOT USED

REMARKS

BCD BIT WEIGHT
W = 8
X = 4
Y = 2
Z = 1

RANGE	CODE		
	a	b	c
200Ω	0	0	1
2K	0	1	0
20K	0	1	1
200K	1	0	0
2000K	1	0	1
20MΩ	1	1	0

6-85. OVERLOAD INDICATION

6-86. The DOU provides a single-bit output indication of a display overload condition. When the digit count exceeds the display capacity pin 6 of the DOU output connector changes from a logic 0 to logic 1.

6-87. RANGE CODE

6-88. The instrument range is presented in a three-bit bcd format at DOU output connector pins H, 7, and F. The output code representing each range is presented in Table 6-4.

6-89. DISPLAY DIGIT

6-90. The numerical value of each digit of the instrument display is presented in a four-bit bcd format at the DOU output connector. The connector pin assignments for each significant digit of the display are provided in Table 6-4. The most significant digit (DOU connector pins 18, 19, V, and W) needs only one active bit to represent the two display digits, 1 or 0. The three remaining bits are connected to ground in the DOU and, in most cases, the corresponding bits in the remote display unit must also be grounded to represent a logic 0.

6-91. DOU INTERFACE CABLE

6-92. A mating DOU connector is supplied with the DOU option for fabrication of a custom interface cable. Use the following procedure when constructing the interface cable.

a. Assemble the following equipment:

1. Teflon or vinyl insulated wire, 26 gauge, 31 pieces cut to the desired length.
2. Sleeving, # 16 for vinyl wire, or # 18 for teflon.
3. Rosin core solder, 60/40.
4. Wire strippers.
5. Soldering iron, pencil-type (45 W max.)
6. DOU mating connector.
7. Mating connector for interface instrument.

b. Strip one-half inch of insulation from the DOU connector end of the wires and tin each wire.

c. Cut 31 pieces of sleeving one-half inch long.

d. Place one piece of sleeving over each prepared wire.

e. Solder a connector contact pin to each wire.

f. Slide the sleeving over each solder connection.

g. Insert one connector contact pin into each DOU mating connector position corresponding to the desired data output.

h. Prepare the mating connector for the interface instrument. Ensure that the data line connections, at the interface instrument mating connector, place the DOU data on the correct pins.

6-93. Theory of Operation

6-94. The DOU receives four lines (W, X, Y, and Z) or data, in character serial format, from the instrument; each line containing eight bits of data. The data lines are sequentially gated, by four successive strobe 5 signals, across an isolation circuit to a series of shift registers. The data from the shift registers is applied through inverting amplifiers to the DOU output connector. A schematic of the DOU circuitry is provided in Figure 7-7.

6-95. The external trigger synchronizing circuit produces an enabling signal that allows the shift registers to accept new data. When a logic 1 is applied to the DOU connector pin D (FREE RUN) the sync circuit will enable the shift registers to update the data with each new input from the instrument. By applying a logic 0 to pin D and a logic 1 to pin B (ARM ENABLE), a positive trigger at pin C (ARM INPUT) will cause the sync circuit to enable the shift registers for the first complete data input that occurs after the arm-input-trigger.

Section 7
Schematic Diagrams

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7-1	Front Panel and Main PCB Assembly	8600A-1011 (Sheet 1 of 2)	7-3
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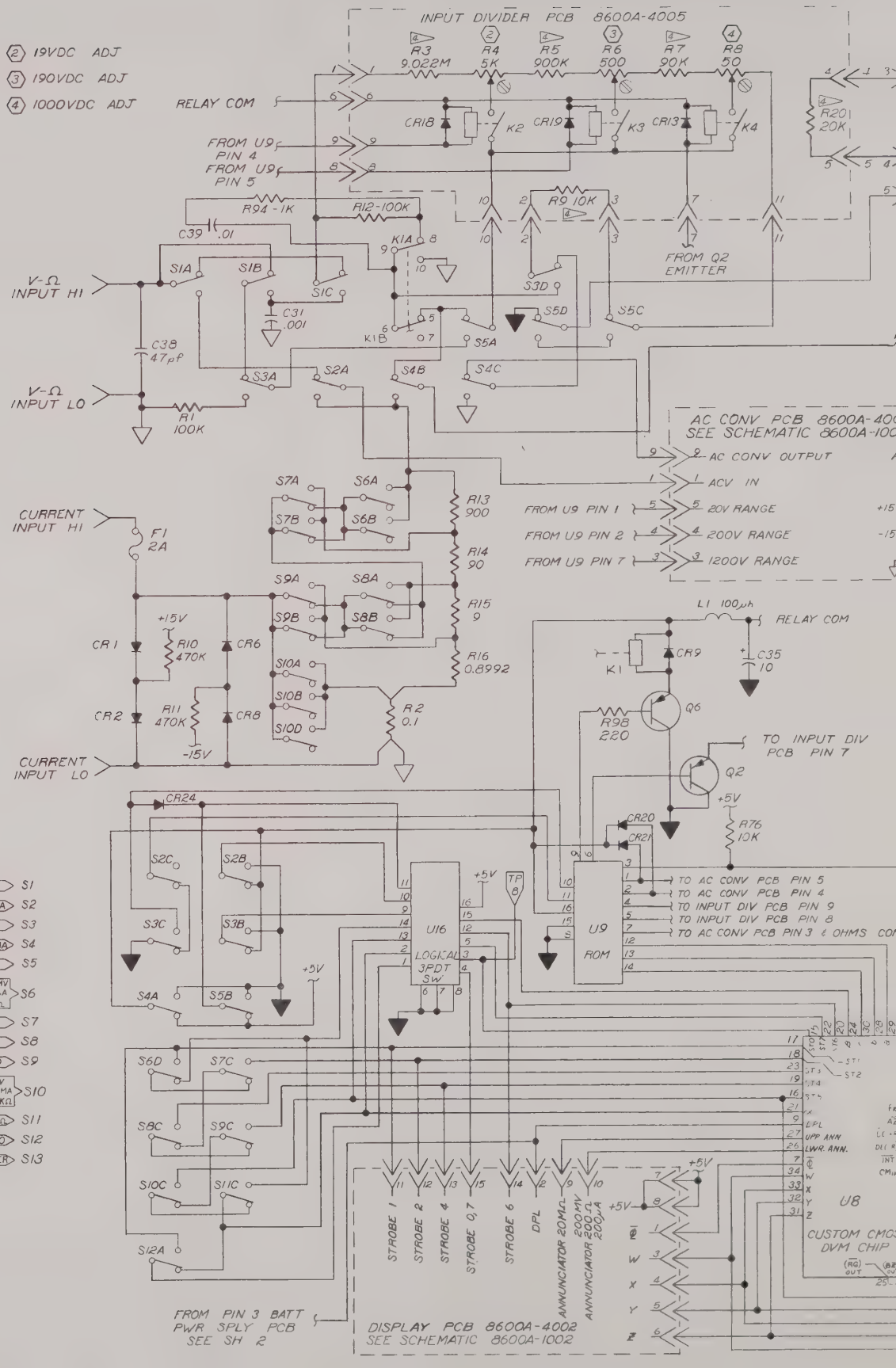

INPUT DIVIDER PCB 8600A-4005
2 19VDC ADJ
3 190VDC ADJ
4 1000VDC ADJ
R3 9.022M
R4 5K
R5 900K
R6 500
R7 90K
R8 50
R20 20K
RELAY COM
CR18
CR19
CR13
K2
K3
K4
FROM U9 PIN 4
FROM U9 PIN 5
R94 - 1K
R12 - 100K
R9 10K
C39 .01
K1A
FROM Q2 EMITTER
V-Ω INPUT HI
S1A
S1B
S1C
S3D
S5D
S5C
C31 .001
C38 47pf
K1B
S5A
V-Ω INPUT LO
S3A
S2A
S4B
S4C
R1 100K
AC CONV PCB 8600A-400
SEE SCHEMATIC 8600A-100
AC CONV OUTPUT
ACV IN
FROM U9 PIN 1
20V RANGE
FROM U9 PIN 2
200V RANGE
FROM U9 PIN 7
1200V RANGE
S7A
S6A
S7B
S6B
R13 900
R14 90
R15 9
R16 0.8992
CURRENT INPUT HI
F1 2A
S9A
S8A
S9B
S8B
S10A
S10B
S10D
R2 0.1
+15V
CR1
R10 470K
CR6
CR2
R11 470K
CR8
-15V
CURRENT INPUT LO
L1 100μh
RELAY COM
CR9
K1
C35 10
R98 220
Q6
TO INPUT DIV PCB PIN 7
Q2
+5V
R76 10K
CR20
CR21
CR24
S2C
S2B
S3C
S3B
S4A
S5B
U16
LOGICAL 3PDT SW
TP 8
U9 ROM
TO AC CONV PCB PIN 5
TO AC CONV PCB PIN 4
TO INPUT DIV PCB PIN 9
TO INPUT DIV PCB PIN 8
TO AC CONV PCB PIN 3 & OHMS CO
ACV S1
AC MA S2
DCV S3
DC MA S4
KΩ S5
200 MV 200 μA 200Ω S6
2 S7
20 S8
200 S9
1200V 2000MA 2000KΩ S10
20MΩ S11
AUTO S12
POWER S13
S6D
S7C
S8C
S9C
S10C
S11C
S12A
STROBE 1
STROBE 2
STROBE 4
STROBE 0,7
STROBE 6
DPL
ANNUNCIATOR 20MΩ
ANNUNCIATOR 200 MV 200 μA
U8
CUSTOM CMOS DVM CHIP
FROM PIN 3 BATT PWR SPLY PCB SEE SH 2
DISPLAY PCB 8600A-4002
SEE SCHEMATIC 8600A-1002

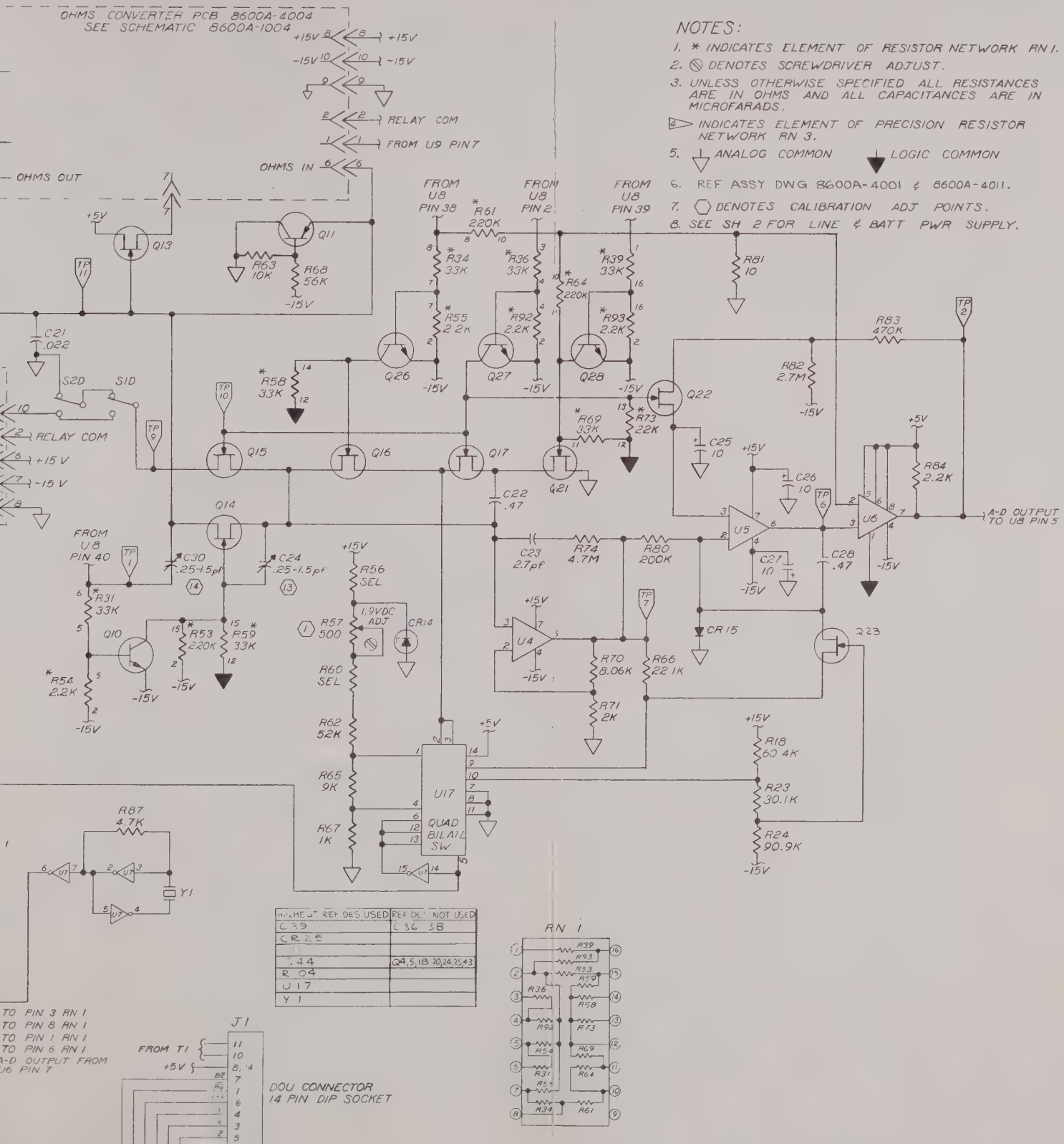
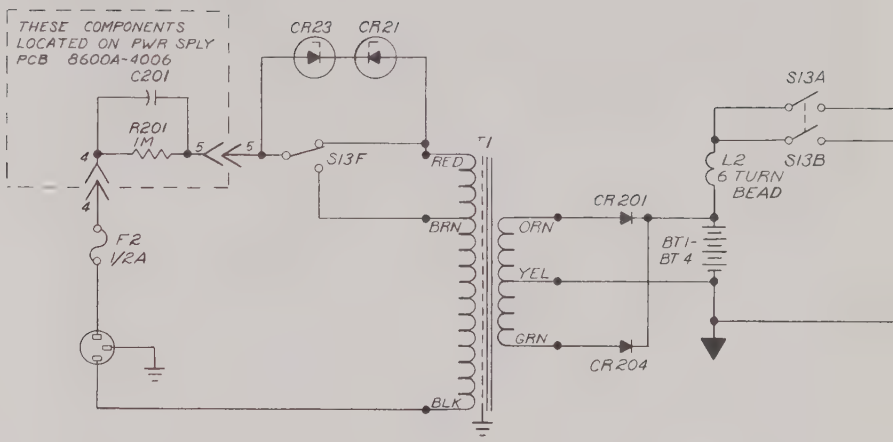
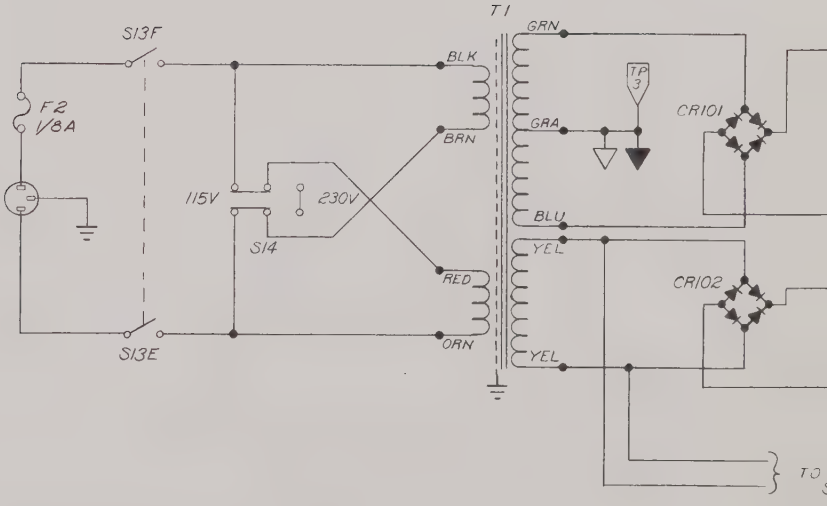


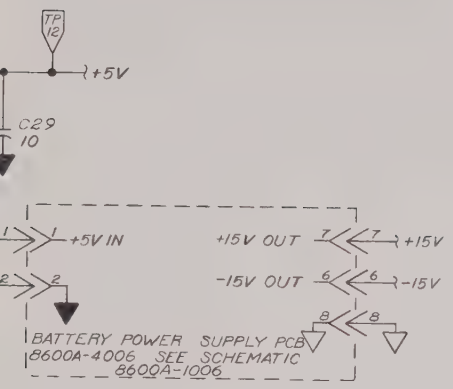
FIGURE 7-1 FRONT PANEL AND MAIN PCB ASSEMBLY (Sheet 1 of 2) (8600A–1001)



BATTERY POWER SUPP



LINE ONLY POWER SUPPLY



NOTES:

1. UNLESS OTHERWISE SPECIFIED ALL RESISTANCES ARE IN OHMS AND ALL CAPACITANCES ARE IN MICROFARADS
2. ⏚ EARTH GROUND
3. ▽ ANALOG COMMON ▼ LOGIC COMMON
4. REF ASSY DWG 8600A-4001 & 8600A-4011
5. SEE SH 1 FOR ALL OTHER MAIN PCB CKTY

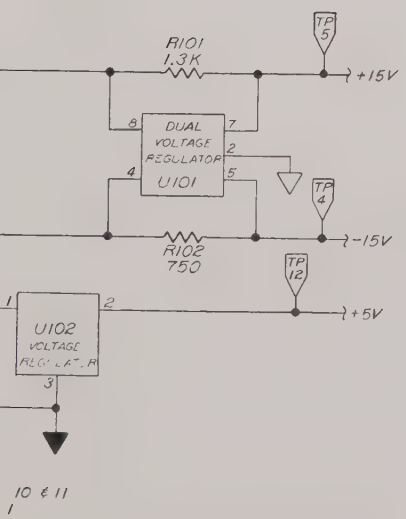
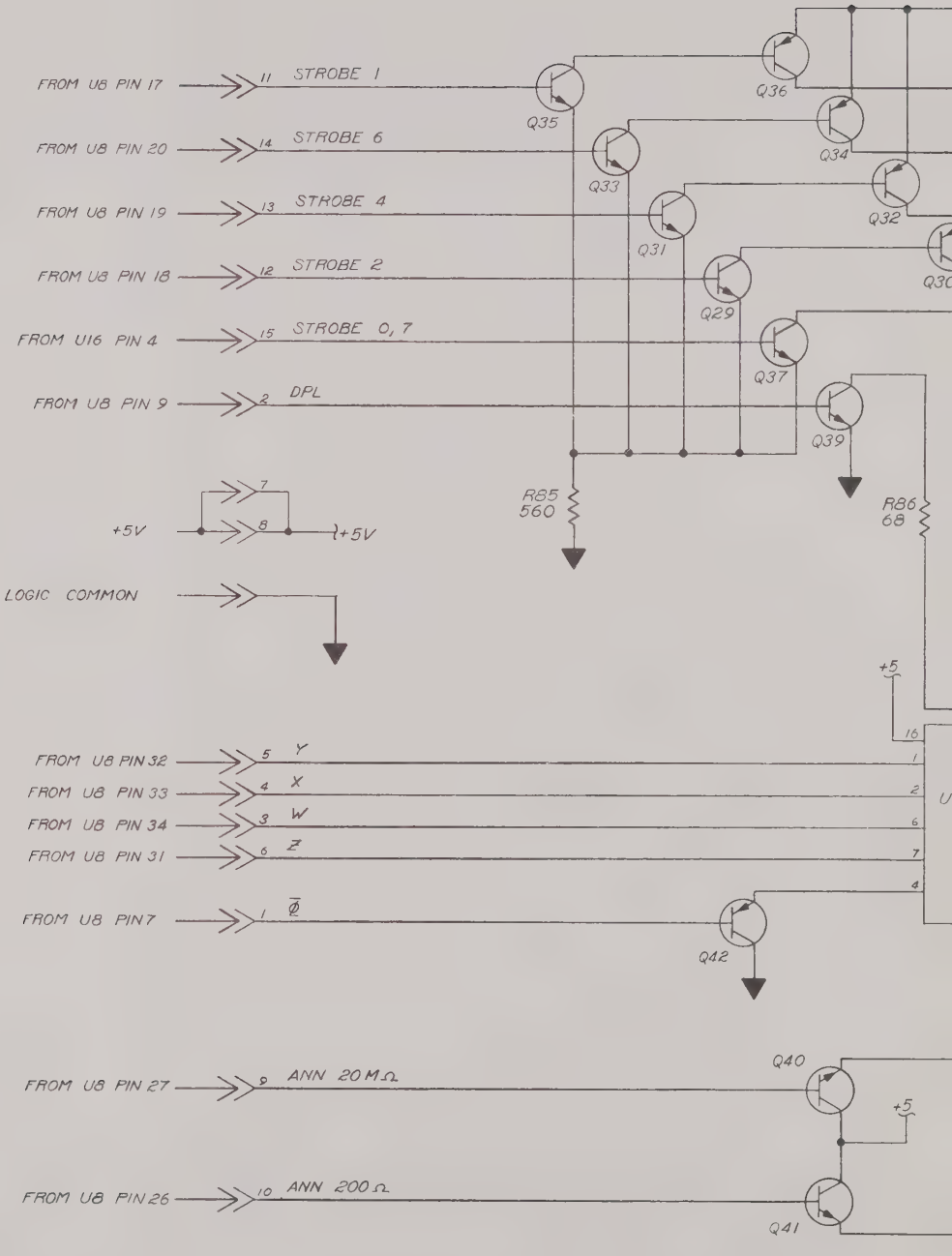
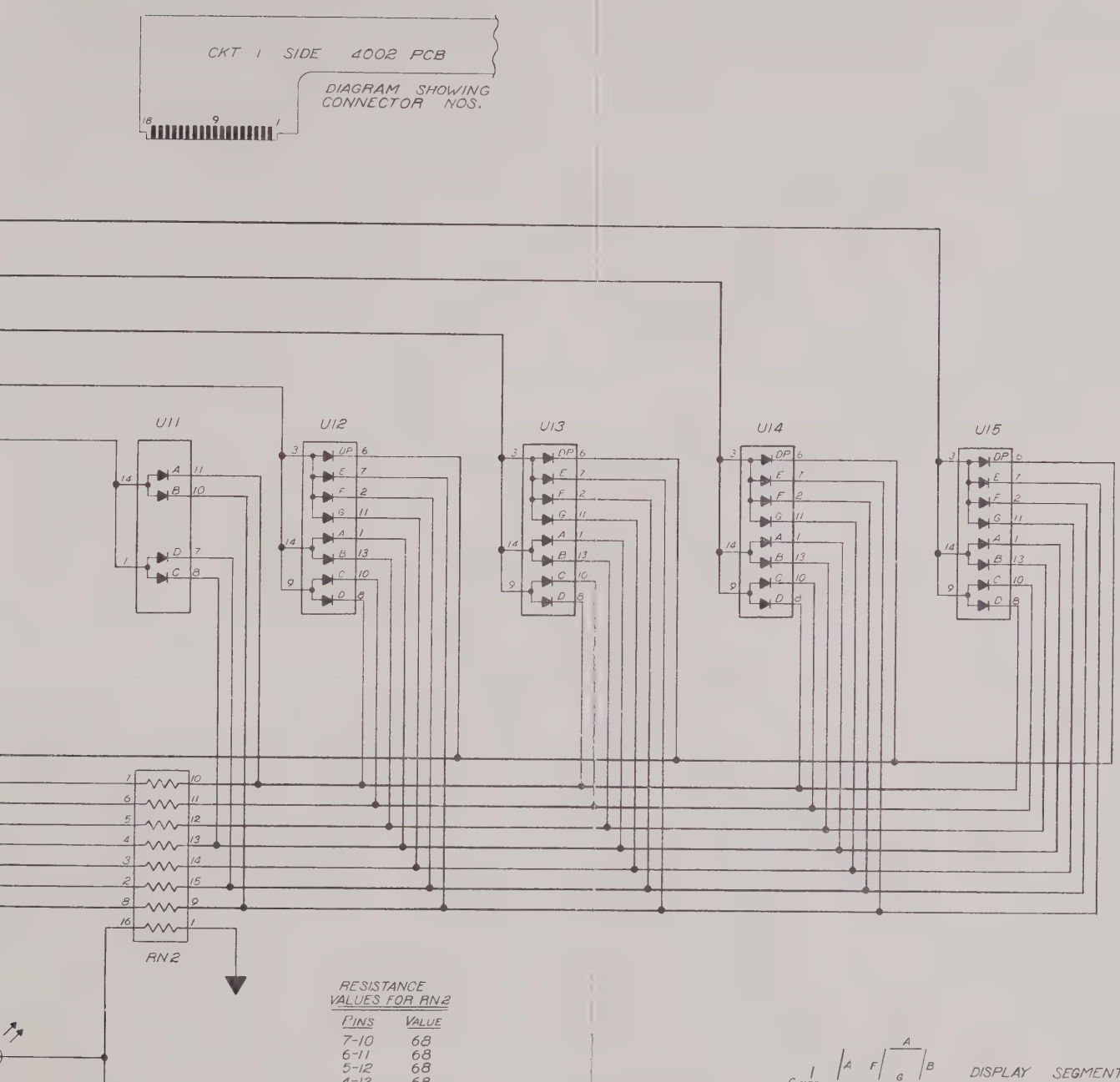


FIGURE 7-2 FRONT PANEL AND MAIN PCB ASSEMBLY (Sheet 2 of 2) (8600A—1001)


FROM U8 PIN 17
11
STROBE 1
FROM U8 PIN 20
14
STROBE 6
FROM U8 PIN 19
13
STROBE 4
FROM U8 PIN 18
12
STROBE 2
FROM U16 PIN 4
15
STROBE 0, 7
FROM U8 PIN 9
2
DPL
+5V
7
8
+5V
LOGIC COMMON
Q35
Q33
Q31
Q29
Q37
Q39
Q36
Q34
Q32
Q30
R85
560
R86
68
+5
16
1
2
6
7
4
FROM U8 PIN 32
5
Y
FROM U8 PIN 33
4
X
FROM U8 PIN 34
3
W
FROM U8 PIN 31
6
Z
FROM U8 PIN 7
1
$\bar{\phi}$
Q42
FROM U8 PIN 27
9
ANN 20 MΩ
FROM U8 PIN 26
10
ANN 200Ω
Q40
+5
Q41



RESISTANCE VALUES FOR RN2

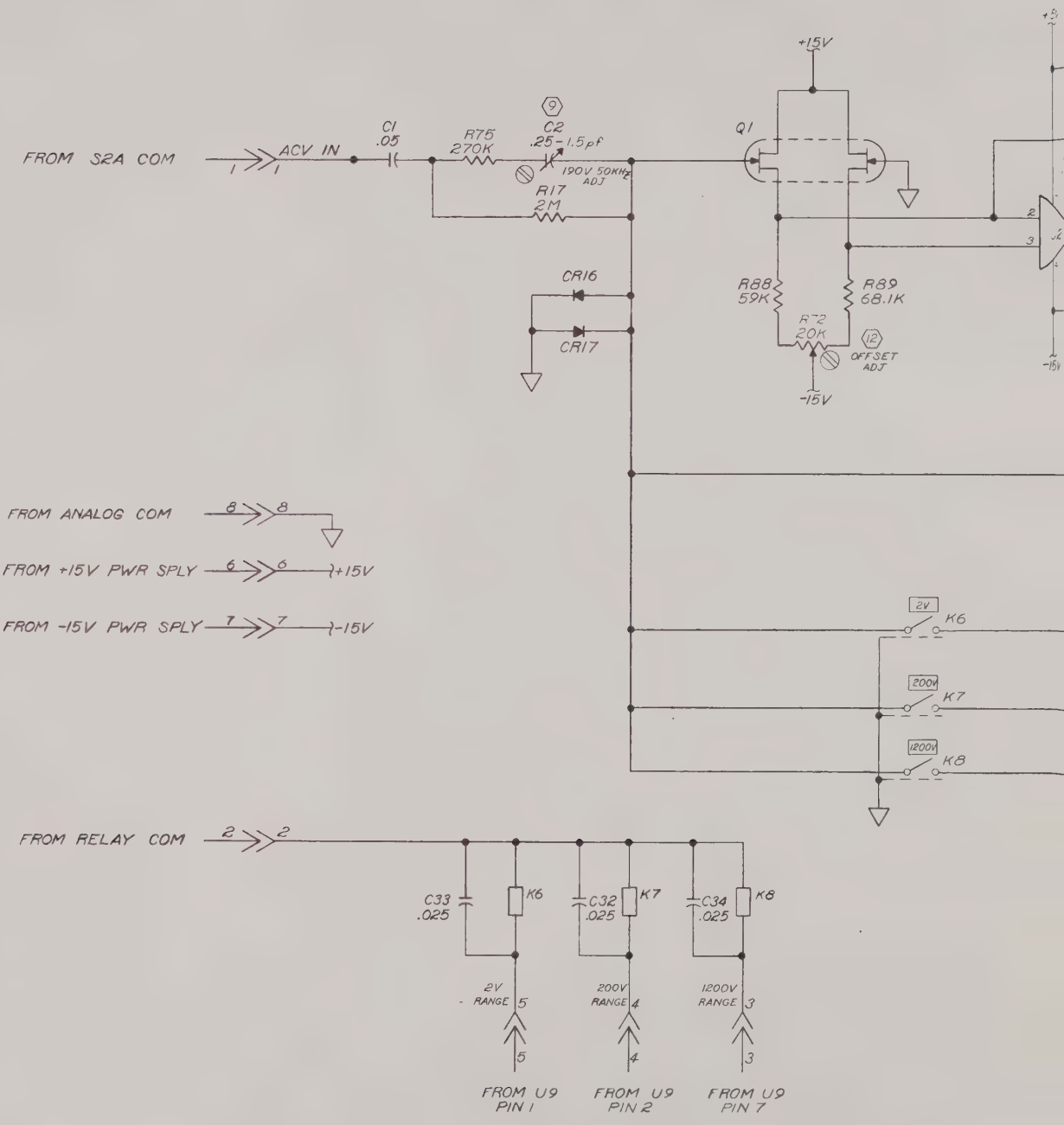
PINS	VALUE
7-10	68
6-11	68
5-12	68
4-13	68
3-14	68
2-15	68
8-9	68
16-1	270

DISPLAY SEGMENTATI

NOTE:

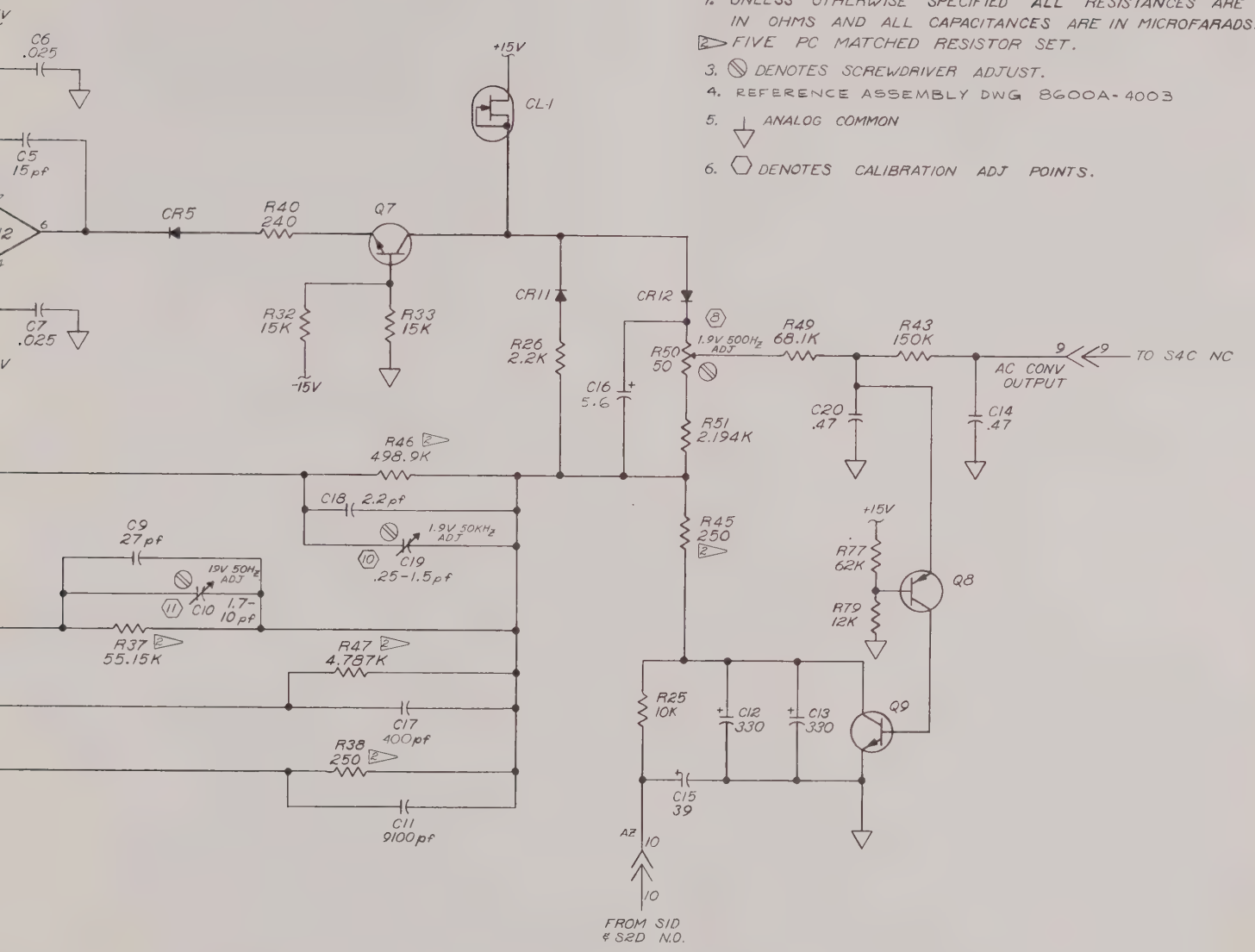
1. UNLESS OTHERWISE SPECIFIED ALL RESISTANCES ARE IN OHMS.
2. REFERENCE ASSY DWG 8600A-4002.

FIGURE 7-3 DISPLAY PCB ASSEMBLY (8600A–1002)


FROM S2A COM
ACV IN
C1
.05
R75
270K
C2
.25-1.5pf
190V 50KHz ADJ
R17
2M
Q1
+15V
-15V
CR16
CR17
R88
59K
R89
68.1K
R72
20K
OFFSET ADJ
FROM ANALOG COM
FROM +15V PWR SPLY
+15V
FROM -15V PWR SPLY
-15V
2V
200V
1200V
K6
K7
K8
FROM RELAY COM
C33
.025
C32
.025
C34
.025
2V RANGE
200V RANGE
1200V RANGE
FROM U9 PIN 1
FROM U9 PIN 2
FROM U9 PIN 7

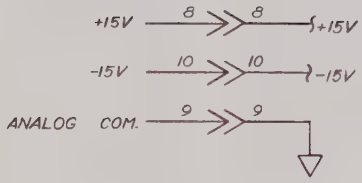
NOTES:

1. UNLESS OTHERWISE SPECIFIED ALL RESISTANCES ARE IN OHMS AND ALL CAPACITANCES ARE IN MICROFARADS.
2. FIVE PC MATCHED RESISTOR SET.
3. DENOTES SCREWDRIVER ADJUST.
4. REFERENCE ASSEMBLY DWG 8600A-4003
5. ANALOG COMMON
6. DENOTES CALIBRATION ADJ POINTS.

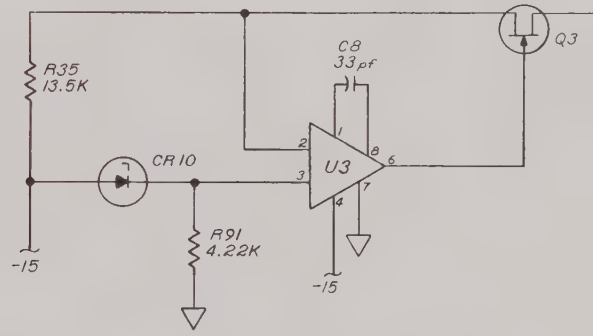


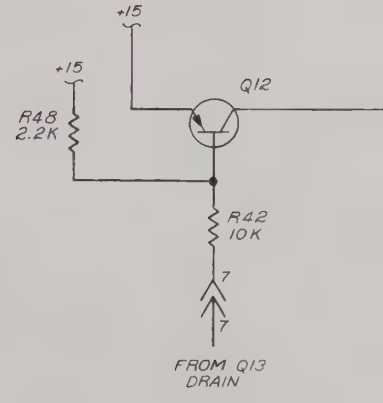
HIGHEST REF DES	REF DES NOT USED
C34	C3,4,8,21-31
CL1	
CR17	CR1-4,6-10,13-15
K8	K1-5
R89	R1-16,18-24,27-31,34-36,39,41,42,44,48,52-71,73-76,78,80-87
Q9	Q2-6
U2	U1

FIGURE 7-4 AC CONVERTER PCB ASSEMBLY (8600A–1003)


+15V
8
8
+15V
-15V
10
10
-15V
ANALOG COM.
9
9

A-D & OHMS CONV INPUT
6
6
OHMS IN


R35
13.5K
C8
33 pf
Q3
CR10
U3
R91
4.22K
-15
-15


+15
+15
Q12
R48
2.2K
R42
10K
FROM Q13
DRAIN

NOTES:

1. UNLESS OTHERWISE SPECIFIED ALL RESISTANCES ARE IN OHMS AND ALL CAPACITANCES ARE IN MICROFARADS.
2. ⊘ DENOTES SCREWDRIVER ADJUST.
3. ▷1 ▷2 FACTORY SELECTED VALUE.
4. ⏚ ANALOG COMMON
5. ⬡ DENOTES CALIBRATION ADJ POINTS.
6. REFERENCE ASSY DWG 8600A-4004

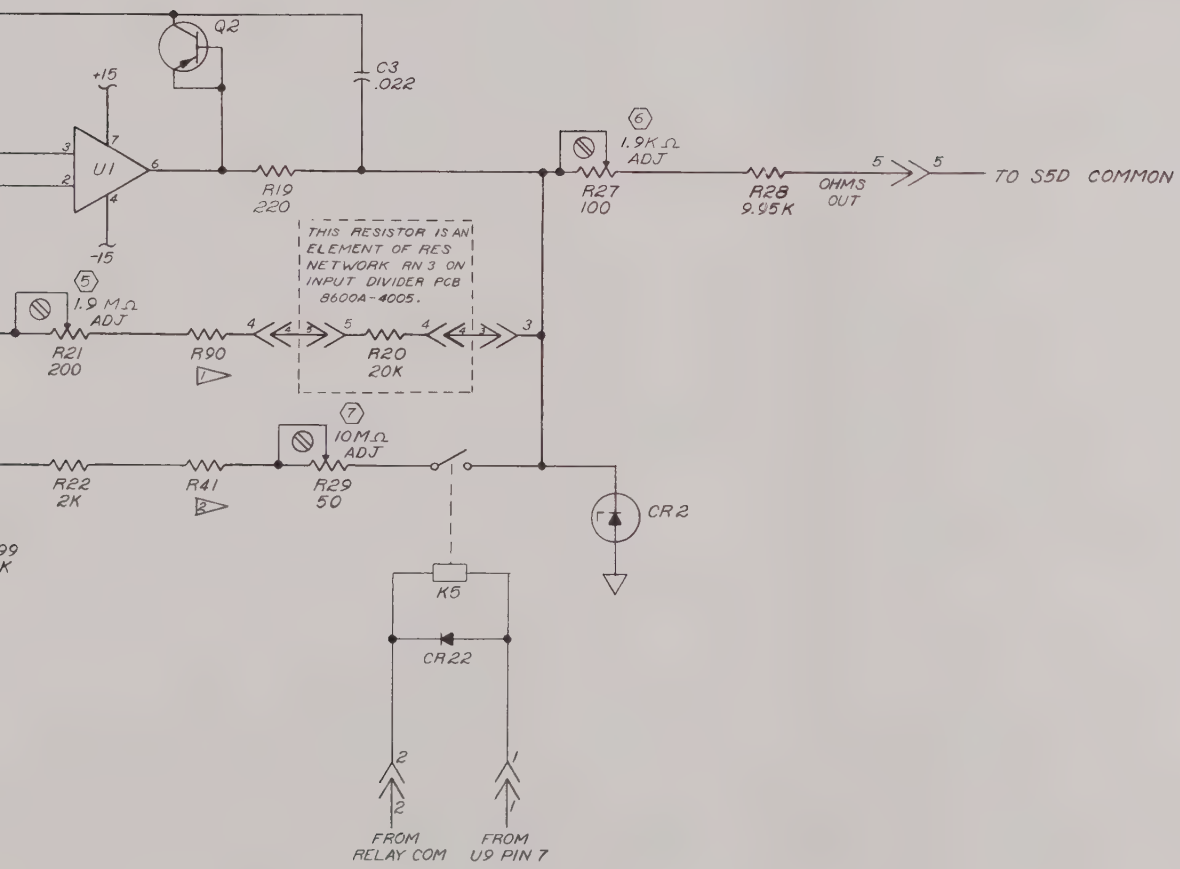
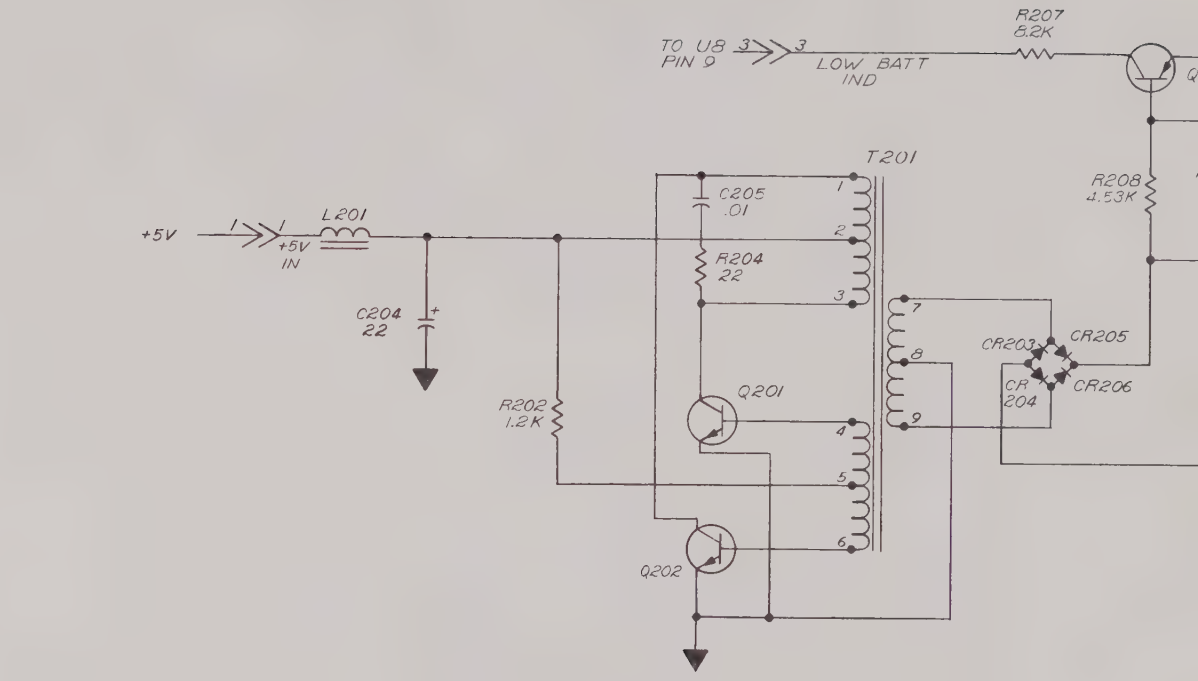
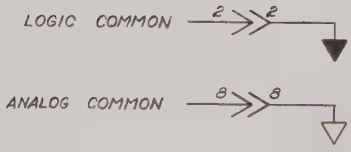
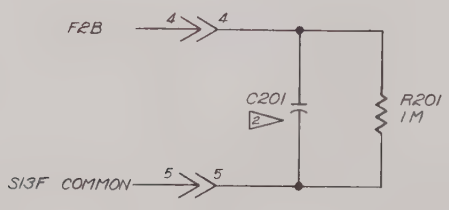


FIGURE 7-5 OHMS CONVERTER PCB ASSEMBLY (8600A–1004)

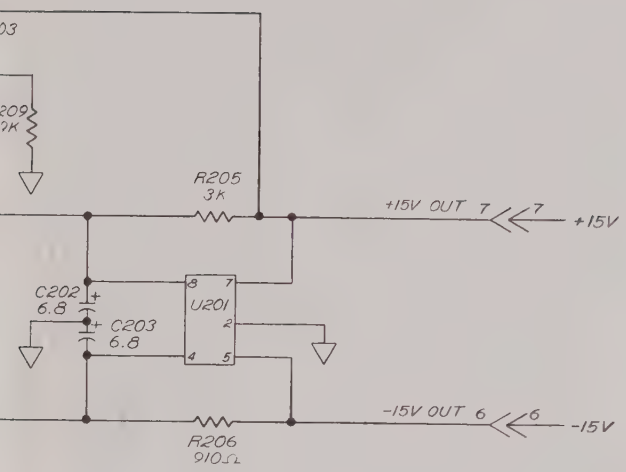

TO U8 PIN 9
3
3
LOW BATT IND
R207 8.2K
T201
R208 4.53K
C205 .01
L201
+5V
1
1
+5V IN
R204 22
C204 22
R202 1.2K
Q201
Q202
CR203
CR205
CR 204
CR206
1
2
3
4
5
6
7
8
9


LOGIC COMMON
2
2
ANALOG COMMON
8
8


F2B
4
4
C201
2
R201 1M
SI3F COMMON
5
5

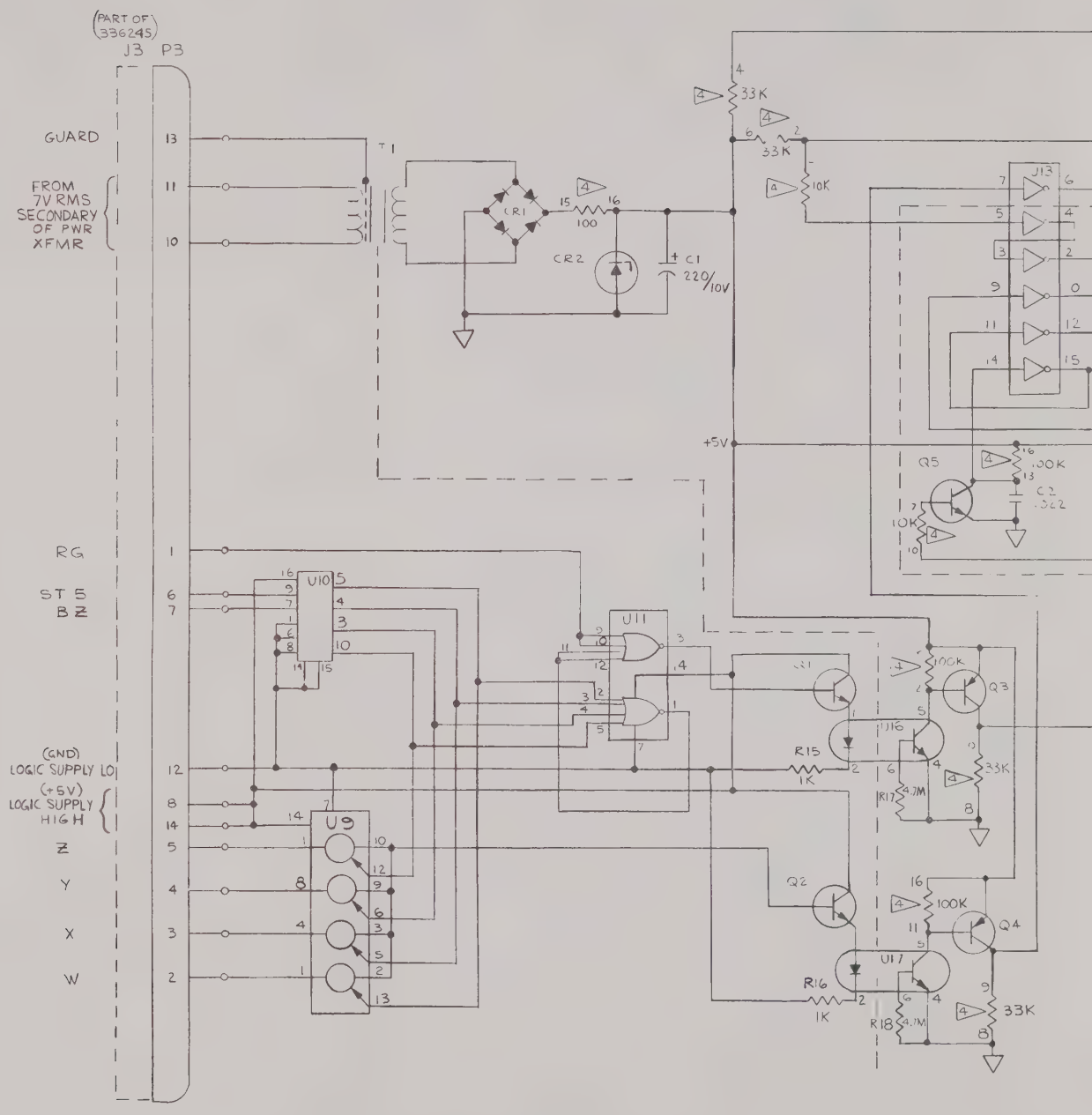
NOTES:

1. UNLESS OTHERWISE SPECIFIED ALL RESISTANCES ARE IN OHMS AND ALL CAPACITANCES ARE IN MICROFARADS.
2. CAPACITOR VALUE SELECTED FOR AC LINE VOLTAGE (i.e. 115, 230, etc.).
3. REF A$SY DWG 8600A-4006.
4. ANALOG COMMON LOGIC COMMON



HEST REF DES	REF DES NOT USED
205	
206	CR201, 202
201	
203	
09	R203
201	
201	

FIGURE 7-6 BATTERY POWER SUPPLY PCB ASSEMBLY (8600A—1006)



NOTES:

UNLESS OTHERWISE SPECIFIED;

1. ALL RESISTANCE VALUES IN OHMS, TOL ± 5%.
2. ALL CAPACITANCE VALUES IN MICROFARADS.
3. U15 IS NOT REQUIRED ON 8600A.
4. PART OF RN1 (RESISTOR NETWORK
5. PART OF U5.
6. PART OF U6.
7. JUMPER AS REQUIRED
8. SEE 8800A-4005 FOR ASSY.

HIGHEST REF DES	REF DES NOT USED
C4	
CR2	
U17	
Q5	
R18	
RN1	
T1	

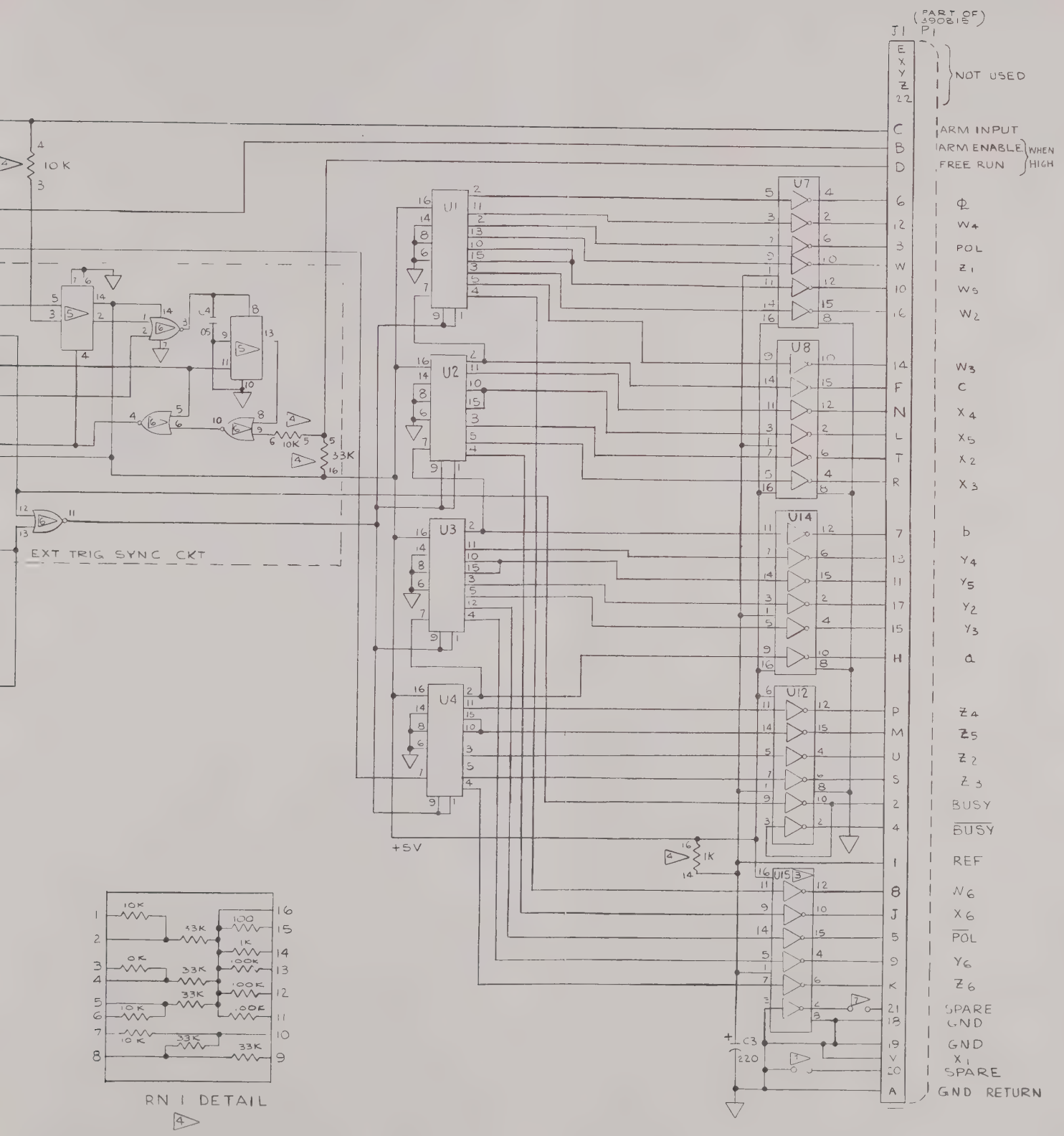


FIGURE 7-7 DATA OUTPUT UNIT PCB ASSEMBLY (8600A–1005)

Appendix A

Federal Supply Code for Manufacturers

A-1. CODE TO NAME

A-2. The following five digit code numbers are listed in numerical sequence along with the manufacturer's name and address to which the code has been assigned. The Federal Supply Code has been taken from Cataloging Handbook H 4-2, Code to Name.

00213 Sage Electronics Corp.
Rochester, New York

00327 Welwyn International, Inc.
Westlake, Ohio

00656 Aerovox Corp.
New Bedford, Massachusetts

00686 Film Capacitors
Passaic, New Jersey

00779 AMP Inc.
Harrisberg, Pennsylvania

01121 Allen-Bradley Co.
Milwaukee, Wisconsin

01281 TRW Semiconductors
Lawndale, California

01295 Texas Instruments, Inc.
Semiconductor Components Div.
Dallas, Texas

01686 RCL Electronics Inc.
Manchester, New Hampshire

01730 Deleted

01884 Dearborn Electronics Inc.
Orlando, Florida

02114 Ferroxcube Corp.
Saugerties, New York

02606 Replaced by 15801

02660 Amphenol-Borg Elect. Corp.
Broadview, Illinois

02799 Arco Capacitors, Inc.
Torrence, California

03508 General Electric Co.
Semiconductor Products
Syracuse, New York

03614 Replaced by 71400

03651 Replaced by 44655

03797 Eldema Corp.
Compton, California

03877 Transitron Electronic Corp.
Wakefield, Massachusetts

03888 Pyrofilm Resistor Co., Inc.
Cedar Knolls, New Jersey

03911 Clairex Corp.
New York, New York

03980 Muirhead Instruments, Inc.
Mountainside, New Jersey

04009 Arrow Hart and Hegemen
Electronic Company
Hartford, Connecticut

04062 Replaced by 72136

04202 Replaced by 81312

04217 Essex Wire Corp.
Wire & Cable Div.
Anaheim, California

04221 Aemco, Div. of
Midtex Inc.
Mankato, Minnesota

04222 Aerovox Corp. (H-Q)
Myrtle Beach, South Carolina

04645 Replaced by 75376

04713 Motorola Semiconductor Products Inc.
Phoenix, Arizona

05082 Replaced by 94154

05236 Jonathan Mfg. Co.
Fullerton, California

05277 Westinghouse Electric Corp.
Semiconductor Dept.
Youngwood, Pennsylvania

05278 Replaced by 43543

05397 Union Carbide Corp.
Electronics Div.
Cleveland, Ohio

05279 Southwest Machine & Plastic Co.
Los Angeles, California

05397 Union Carbide Corp.
Electronics Div.
New York, New York

05571 Sprague Electric Co.
Pacific Div.
Los Angeles, California

05574 Viking Industries
Chatsworth, California

05704 Alac, Inc.
Glendale, California

05820 Wakefield Engineering Ind.
Wakefield, Massachusetts

06001 General Electric Company
Capacitor Department
Irmo, South Carolina

06136 Replaced by 63743

06473 Amphenol Space & Missile Sys.
Chatsworth, California

06555 Beede Electrical Instrument Co.
Penacook, New Hampshire

06739 Electron Corp.
Littletown, Colorado

06743 Clevite Corp.
Cleveland, Ohio

06751 Semcor Div., Components, Inc.
Phoenix, Arizona

06860 Gould National Batteries Inc.
City of Industry, California

06980 Varian-Eimac
San Carlos, California

07115 Replaced by 14674

07138 Westinghouse Electric
Corp., Electronic
Tube Division
Elmira, New York

07256 Silicon Transistor Corp.
Garden City, New York

07263 Fairchild Semiconductor
Div. of Fairchild Camera
& Instrument Corp.
Mountain View, California

07344 Bircher Co., Inc.
Rochester, New York

07792 Lerma Engineering Corp.
Northampton, Massachusetts

07910 Teledyne Corp.
(Continental Device)
Hawthorne, California

08225 Industro Transistor Corp.
Long Island City, New York

08530 Reliance Mica Corp.
Brooklyn, New York

08792 Discontinued

08806 General Electric Co.
Miniature Lamp Dept.
Cleveland, Ohio

08863 Nylomatic Corp.
Norrisville, Pennsylvania

08988 Skottie Electronics Inc.
Archbald, Pennsylvania

09353 C and K Components
Watertown, Massachusetts

09423 Scientific Components, Inc.
Santa Barbara, California

09922 Burndy Corp.
Norwalk, Connecticut

11236 CTS of Berne
Berne, Indiana

11237 Chicago Telephone of
Calif., Inc. (CTC)
Paso Robles, California

11358 Discontinued

11403 Best Products Co.
Chicago, Illinois

11503	Keystone Mfg. Div. of Avis Industrial Corp. Warren, Michigan
11726	Qualidyne Corp. Santa Clara, California
12014	Chicago Rivet & Machine Co. Bellwood, Illinois
12040	National Semiconductor Corp. Danburry, Connecticut
12060	Diodes, Inc. Chatsworth, California
12136	Philadelphia Handle Co. Camden, New Jersey
12323	Presin Co., Inc. Sheaton, Connecticut
12327	Freeway Washer & Stamping Co. Cleveland, Ohio
12400	Replaced by 75042
12617	Hamlin Inc. Lake Mills, Wisconsin
12697	Clarostat Mfg. Co. Dover, New Hampshire
12749	James Electronics Chicago, Illinois
12856	Micrometals Sierra Madre California
12954	Dickson Electronics Corp. Scottsdale, Arizona
12969	Unitrode Corp. Watertown, Massachusetts
13103	Thermalloy Co. Dallas, Texas
13511	Amphenol Corp. Los Gatos, California
13606	Sprague Electric Co. Transistor Div. Concord, New Hampshire
13839	Replaced by 23732
14099	Semtech Corp. Newbury Park, California
14193	California Resistor Corp. Santa Monica, California
14298	American Components, Inc. Conshohocken, Pennsylvania
14655	Cornell-Dubilier Electronics Newark, New Jersey
14674	Discontinued, see 16299
14752	Electro Cube Inc. San Gabriel, California
14869	Replaced by 96853
15636	Elec-Trol Inc. Northridge, California
15801	Fenwal Electronics Inc. Framingham, Massachusetts
15818	Amelco Semiconductor Div. of Teledyne Inc. Mountain View, California
15849	USLCO, Inc. Mt. Vernon, New York
15898	International Business Machines (IBM) Essex Junction, Vermont
15909	Replaced by 17870
16299	Corning Glass Raleigh, North Carolina
16332	Replaced by 28478
16473	Cambridge Scientific Ind. Inc. Cambridge, Maryland
16742	Paramount Plastics Downey, California
16758	Delco Radio Div. of General Motors Kokomo, Indiana
17001	ITT Cannon Santa Ana, California
17069	Circuit Structures Lab. Upland, California
17856	Siliconix, Inc. Sunnyvale, California
17870	Daven-Div of Thomas A. Edison Ind. – McGraw - Edison Co. Manchester, New Hampshire
18083	Deleted
18178	Vactec Inc. Maryland Heights, Missouri
18612	Vishay Intertechnology Inc. Malvern, Pennsylvania
18736	Voltronics Corp. Hanover, New Jersey
19429	Discontinued, use 89536
19451	Perine Machinery & Supply Co. Seattle, Washington
19701	Electra Mfg. Co. Independence, Kansas
20584	Enochs Mfg. Co. Indianapolis, Indiana
20891	Self-Organizing Systems, Inc. Dallas, Texas
22767	ITT Semiconductors Div. of ITT Palo Alto, California
23050	Product Comp. Corp. Mount Vernon, New York
23732	Tracor Rockville, Maryland
23880	Stanford Applied Engrng. Santa Clara, California
23936	Pamotor Div., Wm. J. Purdy Co. Burlingame, California
24248	Southco Div. of South Chester Corp. Lester, Pennsylvania
24655	General Radio Co. West Concord, Massachusetts
24759	Lenox-Fugle Electronics Plainfield, New Jersey
25403	Amperex Electronic Corp. Semiconductor & Receiving Tube Division Slatersville, Rhode Island
27014	National Semiconductor Corp. Santa Clara, California
27264	Molex Products Downers Grove, Illinois
28425	Bohannon Industries Fort Worth, Texas
28478	Deltrol Controls, Corp. Milwaukee, Wisconsin
28480	Hewlett Packard Co. Palo Alto, California
28520	Heyman Mfg. Co. Kenilworth, New Jersey
29083	Monsanto, Co., Inc. Santa Clara, California
30323	Illinois Tool Works, Inc. Chicago, Illinois
32539	Mura Corp. Great Neck, New York
32767	Griffith Plastic Products Co. Burlingame, California
32879	Advanced Mechanical Components Northridge, California
32897	Erie Technological Products, Incorporated Frequency Control Div. Carlisle, Pennsylvania
33173	General Electric Co., Tube Dept. Owensboro, Kentucky
34333	Silicon General Westminster, California
34335	Advanced Micro Devices. Sunnyvale, California
37942	Mallory, P. R. & Co., Inc. Indianapolis, Indiana
42498	National Company Melrose, Massachusetts
43543	Nytronics Inc. Transformer Co. Div. Alpha, New Jersey
44655	Ohmite Mfg. Co. Skokie, Illinois
49671	Radio Corp. of America New York, New York
49956	Raytheon Company Lexington, Maine
53021	Sanamo Electric Co. Springfield, Illinois
55026	Simpson Electric Company Chicago, Illinois
56289	Sprague Electric Co. North Adams, Massachusetts
58474	Superior Electric Co. Bristol, Connecticut
60399	Torrington Mfg. Co. Torrington, Connecticut
62460	Deleted
63743	Ward Leonard Electric Co. Mount Vernon, New York
64834	West Mfg. Co. San Francisco, California
65092	Weston Instruments Inc. Newark, New Jersey
66150	Winslow Tele-Tronics Inc. Asbury Park, New Jersey
70563	Amperite Company Union City, New Jersey
70903	Belden Mfg. Co. Chicago, Illinois
71002	Birnbach Radio Co., Inc. New York, New York
71236	"FLMENCO" Willimantic, Connecticut
71400	Bussmann Mfg. Div. of McGraw - Edison Co. Saint Louis, Missouri
71450	CTS Corp. Elkhart, Indiana
71468	ITT Cannon Electric Inc. Los Angeles, California
71482	Clare, C. P. & Co. Chicago, Illinois
71590	Centralab Div. of Globe Union Inc. Milwaukee, Wisconsin
71707	Coto Coil Co., Inc. Providence, Rhode Island
71744	Chicago Miniature Lamp Works Chicago, Illinois
71785	Cinch Mfg. Co. & Howard B. Jones Div. Chicago, Illinois
72005	Driver, Wilber B., Co. Newark, New Jersey
72092	Replaced by 06980
72136	Electro Motive Mfg. Co. Willimantic, Connecticut
72259	Nytronics Inc. Berkeley Heights, New Jersey
72354	Deleted
72619	Dialight Corp. Brooklyn, New York
72653	G. C. Electronics Rockford, Illinois
72665	Replaced by 90303
72794	Dzus Fastener Co., Inc. West Islip, New York
72928	Gudeman Co. (Gulton Industries) Chicago, Illinois
72982	Erie Tech. Products Inc. Erie, Pennsylvania
73138	Beckman Instruments Inc. Helipot Division Fullerton, California
73293	Hughes Aircraft Co. Electron Dynamics Div. Torrence, California
73445	Amperex Electronic Corp. Hicksville, New York
73559	Carling Electric Inc. Hartford, Connecticut
73586	Circle F Industries Trenton, New Jersey
73734	Federal Screw Products, Inc. Chicago, Illinois

73743 Fischer Special Mfg. Co.
Cincinnati, Ohio

73899 JFD Electronics Co.
Brooklyn, New York

73949 Guardian Electric Mfg. Co
Chicago, Illinois

74199 Quam Nichols Co.
Chicago, Illinois

74217 Radio Switch Corp.
Marlboro, New Jersey

74276 Signalite Inc.
Neptune, New Jersey

74306 Piezo Crystal Co.
Carlisle, Pennsylvania

74542 Hoyt Elect. Instr. Works
Penacook, New Hampshire

74970 Johnson, E. F., Co.
Waseca, Minnesota

75042 IRC Inc. (Div. of TRW)
Philadelphia, Pennsylvania

75376 Kurz-Kasch, Inc.
Dayton, Ohio

75382 Kulka Electric Corp.
Mount Vernon, New York

75915 Littlefuse Inc.
Des Plaines, Illinois

76854 Oak Mfg. Co.
Crystal Lake, Illinois

77342 Potter & Brumfield
Div. of Amer. Machine & Foundry
Princeton, Indiana

77969 Rubbercraft Corp. of Calif. LTD.
Torrance, California

78189 Shakeproof
Div. of Illinois Tool Works
Elgin, Illinois

78277 Sigma Instruments, Inc.
South Braintree, Massachusetts

78488 Stackpole Carbon Co.
Saint Marys, Pennsylvania

78553 Tinnerman Products
Cleveland, Ohio

79136 Waldes Kohinoor Inc.
Long Island City, New York

79497 Western Rubber Company
Goshen, Indiana

79963 Zierick Mfg. Corp.
New Rochelle, New York

80031 Mepco
Div. of Sessions Clock Co.
Morristown, New Jersey

80145 API Instruments Co.
Chesterland, Ohio

80183 Sprague Products
North Adams, Massachusetts

80294 Bourns Inc.
Riverside, California

80583 Hammarlund Co., Inc.
Mars Hill, North Carolina

80640 Stevens, Arnold Inc.
Boston, Massachusetts

81073 Grayhill Inc.
La Grange, Illinois

81590 Korry Mfg. Co.
Seattle, Washington

81312 Winchester Electronics
Div. of Litton Industries
Oakville, Connecticut

81439 Therm-O-Disc Inc.
Mansfield, Ohio

81483 International Rectifier Corp.
Los Angeles, California

81741 Chicago Lock Corp.
Chicago, Illinois

82305 Palmer Electronics
South Gate, California 90280

82389 Switchcraft Inc.
Chicago, Illinois

82415 Price Electric Corp.
Frederick, Maryland

82872 Roanwell Corp.
New York, New York

82877 Rotron Mfg. Co., Inc.
Woodstock, New York

82879 ITT Wire & Cable Div.
Pawtucket, Rhode Island

83003 Varo Inc.
Garland, Texas

83298 Bendix Corp.
Electric Power Division
Eatontown, New Jersey

83330 Smith, Herman H., Inc.
Brooklyn, New York

83478 Rubbercraft Corp. of America
New Haven, Connecticut

83594 Burroughs Corp.
Electronic Components Div.
Plainfield, New Jersey

83740 Union Carbide Corp.
Consumer Products Div.
New York, New York

84171 Arco Electronics, Inc.
Great Neck, New York

84411 TRW
Ogallala, Nebraska

86577 Precision Metal Products
Stoneham, Massachusetts

86684 Radio Corp. of America
Electronic Components & Devices
Harrison, New Jersey

86689 Deleted

87034 Marco-Oak Inc.
Anaheim, California

88245 Litton Products Inc.
Van Nuys, California

88419 Use 14655

88690 Replaced by 04217

89536 Fluke, John Mfg. Co., Inc.
Seattle, Washington

89730 Replaced by 08806

90201 Mallory Capacitor Co.
Indianapolis, Indiana

90215 Best Stamp & Mfg. Co
Kansas City, Missouri

90211 Square D Co.
Chicago, Illinois

90303 Mallory Battery Co.
Tarrytown, New York

91293 Johanson Mfg. Co.
Boonton, New Jersey

91407 Replaced by 58474

91502 Associated Machine
Santa Clara, California

91506 Augat
Attleboro, Mass.

91637 Dale Electronics Inc.
Columbus, Nebraska

91662 Elco Corp.
Willow Grove, Pennsylvania

91737 Gremar Mfg Co., Inc. (ITT)
Woburn, Massachusetts

91802 Industrial Devices, Inc.
Edgewater, New Jersey

91836 King's Electronics
Tuckahoe, New York

91929 Honeywell Inc.
Micro Switch Div.
Freeport, Illinois

91934 Miller Electric Co., Inc.
Pawtucket, Rhode Island

93332 Sylvania Electric Products
Semiconductor Products Div
Woburn, Massachusetts

94145 Replaced by 49956

94154 Tung-Sol
Div. of Wagner Electric Corp.
Newark, New Jersey

95146 Alco Electronics Products Inc.
Lawrence, Massachusetts

95263 Leecraft Mfg. Co.
Long Island City, New York

95264 Replaced by 98278

95275 Vitramon Inc.
Bridgeport, Connecticut

95303 Radio Corp. of America
Solid State & Receiving Tube Div.
Cincinnati, Ohio

95354 Methode Mfg. Corp.
Rolling Meadows, Illinois

95712 Dage Electric Co., Inc.
Franklin, Indiana

95987 Weckesser Co. Inc.
Chicago, Illinois

96733 San Fernando Electric Mfg. Co.
San Fernando, California

96853 Rustrak Instrument Co.
Manchester, New Hampshire

96881 Thomson Industries, Inc.
Manhasset, New York

97540 Master Mobile Mounts
Div. of Whitehall Electronics Corp.
Los Angeles, California

97913 Industrial Electronic Hdware Corp.
New York, New York

97945 White, S. S. Co.
Plastics Div.
New York, New York

97966 Replaced by 11358

98094 Replaced by 49956

98159 Rubber-Teck, Inc.
Gardena, California

98278 Microdot Inc.
Pasadena, California

98291 Sealectro Corp.
Conhex Div.
Mamaroneck, New York

98388 Accurate Rubber & Plastics
Culver City, California

98743 Replaced by 12749

98925 Deleted

99120 Plastic Capacitors, Inc.
Chicago, Illinois

99217 Southern Electronics Corp.
Burbank, California

99392 STM
Oakland, California

99515 Marshall Industries
Capacitor Div.
Monrovia, California

99779 Barnes Corp.
Lansdowne, Pennsylvania

Toyo Electronics
(R-Ohm Corp.)
Irvine, California 92664

National Connector
Minneapolis, Minn. 55436

Appendix B

List of Abbreviations

alternating current	ac
ampere	A
assembly	assy
binary coded decimal	bcd
bel	B
capacitor	cap
centimeter	cm
ceramic	cer
clockwise	cw
common-mode rejection ratio	cmrr
composition	comp
counterclockwise	ccw
decibel	dB
degree Celsius	°C
degree Fahrenheit	°F
digital voltmeter	dvm
direct current	dc
electrolytic	elect
external	ext
farad	F
field effect transistor	FET
germanium	Ge
giga (10^9)	G
gigahertz	GHz
ground	gnd
guard	gd
henry	H
hertz	Hz
high frequency	hg
hour	h
inch	in
integrated circuit	IC
intermediate frequency	if
internal	intl
kilo (10^3)	k
kilohertz	kHz
kilohm	kΩ
kilovolt	kV
low frequency	lf
maximum	max
mega (10^6)	M
megahertz	MHz
megohm	MΩ
meter	m
micro (10^{-6})	μ
microsecond	μs
milli (10^{-3})	m
milliamperes	mA
millimeter	mm
millisecond	ms
millivolt	mV
minimum	min
nano (10^{-9})	n
nanosecond	ns
negative	neg
ohm	Ω
oscilloscope	scope
parts per million	ppm
peak-to-peak	p-p
pico (10^{-12})	p
picofarad	pF
plus or minus	±
positive	pos
plastic	plstc
printed circuit board	pcb
radio frequency	rf
root mean square	rms
second (time)	s
serial number	SN
silicon	Si
tantalum	Ta
temperature coefficient	TC
tera (10^{12})	T
transformer	xfmr
transistor	xstr
ultra high frequency	uhf
variable	var
very high frequency	vhf
very low frequency	vlf
volt	V
voltage controlled oscillator	vco
watt	W
wirewound	ww

Appendix C

Sales Representatives

ALABAMA

HUNTSVILLE
BCS Associates, Inc.
3322 S. Memorial Parkway
P.O. Box 1273
Tel. (205) 881-6220
Zip 35801

ALASKA

SEATTLE
Showalter-Judd, Inc.
5616 4th Ave. South
Tel. (206) 762-2310
Zip 98108

ARIZONA

PHEONIX
Barnhill Associates
7319 E. Stetson Dr.
Tel. (602) 947-7841
Scottsdale, AZ 85251

CALIFORNIA

LOS ANGELES
Instrument Specialists, Inc.
2020 N. Lincoln Street
Burbank, CA 91504
Tel. (213) 849-7181

SANTA CLARA
Instruments Specialists, Inc.
2359 De La Cruz Blvd.
Tel. (408) 244-1505
Zip 95050

SAN DIEGO
Instrument Specialists, Inc.
4805 Mercury St., Ste. 1
Tel. (714) 565-2555
Zip 92111

COLORADO

DENVER
Barnhill Associates
1170 S. Sheridan Blvd.
Tel. (303) 934-5505
Zip 80226

CONNECTICUT

HARTFORD
Instrument Representatives, Inc.
P.O. Box 165
Glastonbury, CT 06033
Tel. (203) 633-0777

FLORIDA

ORLANDO
BCS Associates, Inc.
940 N. Fern Creek Ave.
Tel. (305) 896-4881
(305) 843-1510
Zip 32803

GEORGIA

DECATUR
BCS Associates, Inc.
2522 Tanglewood Road
Tel. (404) 321-0980
Zip 30033

HAWAII

HONOLULU
Industrial Electronics, Inc.
646 Queen Street
P.O. Box 135
Tel. (808) 533-6095
Zip 96817

ILLINOIS

CHICAGO
Cozzens & Cudahy, Inc.
1301 N. Rand Road
Des Plaines, IL 60016
Tel. (312) 298-3600

INDIANA

INDIANAPOLIS
Cozzens & Cudahy, Inc.
Port O'Call Executive Ctr.
21 Beachway Drive
Tel. (317) 244-2456
Zip 46244

KENTUCKY

VALLEY STATION
BCS Associates, Inc.
4506 Freda Way
Tel. (502) 935-9634
Zip 40272

MARYLAND

BALTIMORE
Electronic Marketing Assoc. Inc.
11501 Huff Court
Kensington, MD 20795
Tel. (301) 881-5300, 744-7700

MASSACHUSETTS

BOSTON
Instrument Representatives, Inc.
109 Massachusetts Ave.
Lexington, MA 02173
Tel. (617) 861-8620

MICHIGAN

DETROIT
WKM Associates, Inc.
1474 East Outer Dr.
Tel. (313) 892-2500
Zip 48234

MINNESOTA

MINNEAPOLIS
Cozzens & Cudahy, Inc.
10800 Lyndale Ave. S.
Tel. (612) 884-4336
Zip 55420

MISSOURI

ST. LOUIS
Cozzens & Cudahy Inc.
P.O. Box 10013
Lambert Field - Zip 63145
Tel. (314) 423-1234

NEW JERSEY

NEWARK
SBM Representatives
1519 Stuyvesant Avenue
Union, NJ 07083
Tel. (201) 687-8737

NEW MEXICO

ALBUQUERQUE
Barnhill Associates
1410 -D Wyoming N.E.
Tel. (505) 299-7658
Zip 87112

NEW YORK

NEW YORK
SBM Representatives
28 Hobby Street
Pleasantville, NY 10570
Tel. (914) 769-1811

ROCHESTER
SBM Representatives
4515 Culver Road
Tel. (716) 226-1400
Zip 14622

NORTH CAROLINA

GREENSBORO
BCS Associates, Inc.
P.O. Box 9619
1310 Beaman Place
Tel. (919) 273-1918
Zip 27408

OHIO

CLEVELAND
WKM Associates, Inc.
16141 Puritas Ave.
Tel. (216) 267-0445
Zip 44135

DAYTON
WKM Associates, Inc.
6073 Far Hills Ave.
Tel. (513) 434-7500
Zip 45459

OREGON

BEAVERTON
Showalter-Judd, Inc.
13485 S.W. Hargis Road
Tel. (503) 646-3004
Zip 97005

PENNSYLVANIA

PHILADELPHIA
Electronic Marketing Assoc.
210 Goddard Blvd., Ste. 100
King of Prussia, PA
Tel. (215) 248-5050
Zip 19406

PITTSBURGH
WKM Associates, Inc.
90 Clairton Blvd.
Tel. (412) 892-2953
Zip 15236

TEXAS

DALLAS
Barnhill Associates
908 Business Parkway
Richardson, TX 75080
Tel. (214) 231-2573

HOUSTON
Barnhill Associates
10606 Hempstead Hwy.
Suite 132
Tel. (713) 688-9971
Zip 77018

VIRGINIA

WILLIAMSBURG
BCS Associates
107 Rich Neck Road
Tel. (703) 229-5108
Zip 23185

WASHINGTON

SEATTLE
Showalter-Judd, Inc.
5616 4th Ave. South
Tel. (206) 762-2310
Zip 98108

CANADA

BRITISH COLUMBIA

NORTH VANCOUVER
Allan Crawford Associates, Ltd.
234 Brooksbank Ave.
Tel. (604) 980-4831

ALBERTA

CALGARY
Allan Crawford Associates, Ltd.
640 - 11th Ave. S.W.
Tel. (403) 261-0780

ONTARIO

MISSISSAUGA
Allan Crawford Associates, Ltd.
6427 Northam Drive
Tel. (416) 678-1500

OTTAWA, 3
Allan Crawford Associates, Ltd.
1299 Richmond Road
Tel. (613) 829-9651

QUEBEC

LONGUEUIL
Allan Crawford Associates, Ltd.
1330 Marie Victorian Blvd. East
Tel. (514) 670-1212

INTERNATIONAL REPRESENTATIVES

ARGENTINA
Coasin S.A.
Virrey del Pino 4071
Buenos Aires, Argentina

AUSTRALIA
Elmeasco Instruments, Pty. Ltd.
P.O. Box 334
Brookvale, N.S.W. Australia 2100

AUSTRIA
KONTRON GmbH & Co. KG
Lederergasse 16
1080 Vienna, Austria

BELGIUM
C.N. Rood S.A.
37 Place de Jamblinne de Meux
B-1040 Brussels, Belgium

BRAZIL
Ambriex S.A.
Rue Ceara, 104 - 2°. e 3.° Andares
ZC-29
Rio de Janeiro GB, Brazil

Ambriex S.A.
Rua Tupi, 535
01233 Sao Paulo SP, Brazil

CARIBBEAN
West Indies Sales Co.
606 Calle Aboy
San Juan, Puerto Rico 00907

CHILE
Coasin Chile Ltd.
Casilla 14588 - Correo 15
Santiago, Chile

CHINA, Peoples Republic Of
May Lee Industries, Inc.
31 East 32nd Street
New York, NY 10016

COLOMBIA
Marones Ltd.
Apartado Aereo 90687
Bogota 8, Colombia

CYPRUS
Chris Radiovision Ltd.
P.O. Box 1989
Nicosia, Cyprus

DENMARK
Tage Olsen A/S
Teglvaerksgade 37
2100 Copenhagen 0, Denmark

ECUADOR
Proteco Coasin Cia, Ltd.
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